BOOK CLIFFS III
CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT
(CHIA)

For

WEST RIDGE MINE
C/007/0041

SUNNYSIDE MINE
C/007/0007

In

CARBON COUNTY, UTAH

September 22, 2005

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I. INTRODUCTION

The Book Cliffs III Cumulative Impact Area (CIA) is located in Carbon County, Utah, in the Book Cliffs Coal Field approximately 25 miles east of the city of Price and immediately north of the towns of East Carbon and Sunnyside (Plate 1). The West Ridge Mine is currently the only active mine in the Book Cliffs III CIA. The CIA also includes the northern two-thirds of the reclaimed Sunnyside Mine (Plate 2). Operations at the Sunnyside Mine ceased in 1994 and the mine site completed final reclamation in 2000 by the Utah Division of Oil, Gas and Mining (UDOGM). The Book Cliffs form a rugged escarpment that faces to the south and southwest and separates the Uintah Basin from the San Rafael Swell. Elevations along the Book Cliffs range from approximately 5,000 to 10,000 feet. Steep, narrow canyons and high peaks are characteristic. Because of the rugged topography land uses are generally limited to wildlife habitat, rangeland, and recreation, but timber is harvested in some areas. A large portion of the surface area is public land managed by the Bureau of Land Management (BLM).

The Book Cliffs area may be classified as mid-latitude steppe to semi-arid desert. The climate is characterized by warm dry summers, moist springs, and by cold, snowy winters. Precipitation varies from 20 inches at the highest elevations to 8 inches along the Price River downstream of the town of Wellington. Mean annual precipitation is about 12 inches, with most precipitation occurring during the late summer and early fall. Temperatures range from summer highs in the 90's to below zero during the winter months.

The only coal mining operation is the West Ridge Mine operated by West Ridge Resources, Inc. West Ridge Resources, Inc. is jointly owned by the Intermountain Power Agency (IPA) and by Andalex Resources, Inc. Surface ownership of the 6,114.89-acre West Ridge permit area is comprised of 3,083.38 acres of federal land, 810.04 acres of state land, and 2,221.47 acres of private land. (Refer to Table 1-3 and Map 5-2 of the West Ridge Mining and Reclamation Plan (MRP).) Federal lease SL-068754 was the original document providing right of entry. In December 2001, West Ridge Resources acquired a Lease by Application (LBA) on federal coal lease UTU-78562. Development mining only of Penta Creek fee coal (124.92 acres) was added to the permit area in April 2005. Utah State Institutional Trust Lands Administration (SITLA) coal leases ML 47711 (801.24) and ML 49287 (881.10 acres) were added in June 2005 and triggered this review and update of the Book Cliffs III CHIA.

The Division has the responsibility to assess the potential for mining impacts both inside and outside permit areas. The CHIA is a findings document prepared by the Division that assesses whether existing, proposed, and anticipated coal mining and reclamation operations have been designed to prevent material damage to the hydrologic balance outside the permit areas. The Division cannot issue a permit to a proposed coal mining operation if the probable, anticipated hydrologic impacts will create material damage to the hydrologic balance outside the permit area. The CHIA is not only a determination if coal mining operations are designed to prevent material damage beyond their respective permit boundaries when considered individually, but also if there will be material damage resulting from effects that may be acceptable when each operation is considered individually, but are unacceptable when the cumulative impact is assessed.

The objective of a CHIA document is to:

1. Identify the Cumulative Impact Area (CIA) **(Part II)**

2. Describe baseline conditions in the CIA; identify hydrologic systems, resources and uses; and document baseline conditions of surface and groundwater quality and quantity **(Part III)**

3. Identify hydrologic concerns **(Part IV)**

4. Identify relevant standards against which predicted impacts can be compared **(Part V)**

5. Estimate probable future impacts of mining activity with respect to the parameters identified in 4 **(Part VI)**

6. Assess probable material damage **(Part VII)**

7. Make a statement of findings **(Part VIII)**

This CHIA complies with the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) and subsequent federal regulatory programs under 30 CFR 784.14(f), and with Utah regulatory programs established under Utah Code Annotated 40-10-et seq. and the attendant State Program rules under R645-301-729.

II. CUMULATIVE IMPACT AREA (CIA)

The Book Cliffs III Cumulative Impact Area (CIA) is shown on Plates 1 and 2. The CIA is the area, within which actual and anticipated coal mining activities may interact to affect the surface and groundwater. The CIA is determined based on anticipated mining activities, knowledge of surface and groundwater resources, and anticipated impacts of mining on those water resources.

The Book Cliffs III CIA encompasses roughly 56,000 acres (88 $mile^2$). The West Ridge Mine is the only active mine in the CIA. The 6114.89-acre West Ridge Mine permit area is comprised of: Federal Coal Leases SL-068754-U-01215 (2,570.67 acres), lease modification to SL-068754 (80.0 acres), and UTU-78562 (1,646.34 acres); State Coal Leases ML 47711 (801.24 acres) and ML 49287 (881.10 acres); and Penta Creek Fee Leases (124.92 acres).

Whitmore Canyon located east of West Ridge is the major surface drainage in the CIA and contains Grassy Trail Creek and the Grassy Trail Reservoir. A, B, C, and Bear Canyons are ephemeral and intermittent drainages cut into the face of the Book Cliffs escarpment on the west side of West Ridge.

SCOPE OF MINING

Sunnyside Mine

Mining at the Sunnyside properties was initiated during the late 1890's. Total coal production has exceeded 55 million tons. Kaiser Steel Corporation acquired the Sunnyside properties in 1950 and operated the mines until April 1985. Kaiser Coal Corporation operated the mines from 1985 until 1994, when operations ceased and Kaiser Coal declared bankruptcy.

Plate 2 shows the extent of Kaiser Coal Corporation's Sunnyside permit area that included, from south to north, the No. 2 Mine, No. 3 Mine and No. 1 Mine. The three mines encompassed the southern three-quarters of the Sunnyside permit area. Future mining was projected to the northwest and would have included the B Canyon and C Canyon areas.

Sunnyside Mines workings are approximately 6.5 miles in length and extend a maximum of 2.5 miles down-dip to the east. The first 5-year permit area encompassed 14,300 acres. Overburden thickness was approximately 1,000 feet to 2,000 feet.

Mining was done in the Upper Sunnyside coal seam in the No. 3 Mine and Lower Sunnyside coal seam in the No. 1 Mine and No. 2 Mine. Sixty-five to 80 % of the coal was to be produced by longwall mining methods, with the remaining production from continuous miner entry development and pillaring in areas unsuitable for longwall methods.

B Canyon is located northwest of the old Sunnyside No. 1 underground mine workings. Federal coal lease SL-068754, of the West Ridge Mine coal tract, was at one time held by U.S. Steel Corp. U.S. Steel authorized Kaiser Coal Company to extend a set of test entries from the

Sunnyside Mine part way through the lease. In 1959 and 1960 Kaiser Coal mined two entries 11,000 feet northwestward, along the strike of the Lower Sunnyside seam, into the center of lease (SL-068754). From these main entries another entry was developed up-dip, to the west, for approximately 2,000 feet before it broke out in B Canyon. This breakout was utilized as an intake air portal until 1991 when it was sealed and backfilled. The Sunnyside Mine test entries are now inactive and sealed to prevent public access. Only development work was performed, no pillars were pulled.

West Ridge Mine

C Canyon is located approximately 1 mile northwest of B Canyon. The surface facilities for the West Ridge Mine are situated in C Canyon, north of the old underground mine workings of the Sunnyside No. 1 Mine.

In the mid-1950's the road along the bottom of C Canyon was constructed to a drill site in the right fork. The road was improved again in 1985 to facilitate drilling equipment for a water monitoring drill hole in the right fork. Another road leads up the left fork to the coal outcrop. The Lower Sunnyside seam was exposed and coal removed for testing purposes, probably using hand tools or a loader. The size of the excavation indicates less than one ton of coal was removed. This coal outcrop excavation was done sometime in the late 1960's or early 1970's.

West Ridge Resources, Inc. (West Ridge) began mining in this area in January 2000. Both continuous and longwall mining methods are currently used. Pillars will be fully extracted unless they are needed for safety or to protect the outcrop. Table 1 shows the annual coal production for the West Ridge Mine as reported by the Mine Safety and Health Administration (MSHA).

Annual Production in millions of tons West Ridge Mine		
Year	**Production**	**Source**
2000	0.53	(MSHA)
2001	2.29	(MSHA)
2002	2.83	(MSHA)
2003	2.97	(MSHA)
2004	2.27	(MSHA)

Table 1

III. HYDROLOGIC SYSTEM and BASELINE CONDITIONS

Elevations range from approximately 6,000 to over 9,000 feet in the Book Cliffs III CIA. Predominant features that exist in the CIA are cliffs, narrow canyons, valleys and pediments. Drainage in the CIA is characterized by a system of ephemeral and intermittent streams draining the southwest-facing Book Cliffs escarpment and a perennial stream (Grassy Trail Creek) that drains to the southeast through Whitmore Canyon.

GEOLOGY

Stratigraphy

The stratigraphy of the Book Cliffs CIA consists of strata ranging in age from Late Cretaceous to Tertiary (Eocene) as seen in Plate 3. There are no major disconformities in the area. The oldest exposed rocks include the upper members of the Mancos Shale. The Cretaceous Mesaverde Group, which in the Book Cliffs consists of the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone and Price River Formation, overlies the Mancos Shale. Overlying the Mesaverde Group are the North Horn Formation, Flagstaff Limestone, Colton Formation, and Green River Formation, which in the Book Cliffs constitute the Wasatch Group of Paleocene to Eocene age. The Eocene Green River Formation is the uppermost consolidated formation in the CIA. Unconsolidated deposits formed by weathering and erosion exist as soils, terrace deposits, gravels along canyon streams, and pediments at the base of escarpments.

Coal

In the West Ridge and C Canyon area, the four lowest coal seams or zones in the Blackhawk Formation are not mineable, because the coal deposits are thin and of limited extent. The lowest seam, the Kenilworth, rests directly or just above the massive Kenilworth Sandstone Member of the Blackhawk Formation. Thickness averages two feet along the outcrop and does not exceed four feet anywhere on the West Ridge property. About 20 to 30 feet above the Kenilworth seam is the Gilson coal horizon. Thicknesses in the range of 12 feet have been measured in the vicinity of Pace Canyon, but the Gilson seam splits and thins to the southeast and at Whitmore Canyon the coal has been replaced by marine sands. Over the northern portion of the West Ridge lease area the main Gilson bed is less than two feet. The Fish Creek coal horizon lies about 15 to 25 feet above the Gilson seam, but coal thickness averages only one to two feet in the West Ridge lease area. About 55 to 70 feet above the Gilson seam is the Rock Canyon coal zone, but it does not contain a developed coal seam in the West Ridge lease area.

The principal coal-bearing horizon beneath the West Ridge Mine permit area is the Sunnyside coal zone. This zone begins 125 feet above the Rock Canyon horizon and ends 200 to 275 feet below the Castlegate Sandstone. This zone varies between several feet to more than 60 feet in thickness. Within this zone nine coal beds were identified in the Sunnyside Mines. The bottom three beds have been assigned to the Lower Sunnyside Seam and the remainder to the Upper Sunnyside Seam.

The Lower Sunnyside Seam is the most important coal seam in the West Ridge area. To the north and west of C Canyon the Lower Sunnyside seam occurs as a single seam. Thickness exceeds 6 feet throughout most of the lease area, but thins to the south and east where one or two rider seams are present above the main coal seam. Neither rider seam reaches mineable thickness, but to the south, in the vicinity of the Sunnyside Mines, the rider seams combine with the Upper Sunnyside to form a single seam 10 to 15 feet thick. Throughout the lease area the Lower Sunnyside Seam has a sandstone floor and the roof is composed of either a black sandy shale or a fine grained sandstone with shale partings.

The Upper Sunnyside Seam is the least defined of the coal horizons. Its six beds tend to be lenticular and correlation between widely spaced data points is difficult. Overall thickness is from 2 to 15 feet in the Sunnyside Mines. In the West Ridge lease area the average seam height is less than 4 feet. Because of its thinness and close proximity to the Lower Sunnyside Seam, none of the Upper Sunnyside is considered to be mineable at West Ridge.

Overburden depth exceeds 2,500 feet for the Lower Sunnyside seam. The average overburden under the West Ridge permit area is approximately 1,500 feet (West Ridge Mine MRP).

Structure

Strata in the Book Cliffs were tilted in response to the rise of the San Rafael Swell and Socally and Farnam anticlines, and modified by subsequent erosional, tectonic and orogenic events. Strike of the beds at the West Ridge Mine site is northwest-southeast, generally parallel to the face of the Book Cliffs. Dip is 7 degrees to the northeast in the West Ridge Mine area; however dips in the area are often as much as 19 degrees in places along the Book Cliffs escarpment, and decrease to as little as 4 degrees several miles back from the escarpment, such as in the deeper parts of the Sunnyside No. 1 Mine and at outcrops in upper Whitmore Canyon (Osterwald and others, 1981). This appears to be the result of elastic rebound of the Mancos Shale as overlying material has been removed by erosion (Duguid, 1981).

Joints occur in two principal and two secondary orientations, although orientations are more accurately related to the local strike of the strata rather than to a specific direction. All joints tend to dip steeply. Retreat of the Book Cliffs escarpment has probably been facilitated significantly by blocks of rock breaking from the cliffs along joints, and soils and vegetative cover develop in large troughs formed as these blocks pull away. Northwest to north-northwest joints tend to be the most variable in orientation. They generally are parallel to strike of the strata and at right angles to the canyons and ridges of the escarpment. Locally they occur as little as 1 foot apart in zones a few feet wide, zones being a few feet to 20 feet apart. There has been vertical movement on some of these joints and some are coated with gypsum or calcite. Northeast to north-northeast joints are generally normal to the northwest to north-northwest joints and tend to be parallel to dip. There are also west-northwest and northeast trending joint sets (Osterwald and others, 1981).

There are few faults mapped in the CIA, and faulting does not seem to be an important factor in the geology or hydrology of this particular area. The Sunnyside fault is a major north-northwest striking fault throughout much of the Sunnyside Mining District to the south (Osterwald and others, 1981). Displacement on this fault decreases northward, and although this fault is detectable from surface mapping in Whitmore Canyon, it does not appear to extend as far as the West Ridge mine permit area. Two small faults have been mapped just to the northeast of the West Ridge mine area (Map 6-1 of the West Ridge MRP). Maps produced by the Utah Geological Survey (Doelling, 1972) indicate at least two other faults, that strike approximately northwest-southeast in the area of Bear, C, and B Canyons. During a 1997 field survey by Agapito Associates, Inc., consulting for the West Ridge Mine permit application, did not locate faults in this area.

HYDROLOGY

Plate 4 shows locations for all surface water monitoring sites (streams and UPDES sites) and groundwater monitoring sites (springs and wells).

Groundwater

Recharge in the Wasatch Plateau and Book Cliffs coal fields has been estimated to be 3 to 8 % (Danielson and Sylla, 1983) and 9 % (Waddell and others, 1986) of the average annual precipitation. Snowmelt provides most of the groundwater recharge. In the Book Cliffs the recharge rate is generally greatest where limestones of the Flagstaff Formation are exposed as dip-slopes at the higher elevations, but the Flagstaff is thin in the CIA and is not exposed on dip slopes (Plate 2 in Osterwald and others, 1981).

Once recharge enters the ground, the rate and direction of groundwater flow is governed mainly by gravity and geology. Lateral groundwater flow dominates in the gently-dipping Tertiary and Cretaceous strata of the Book Cliffs, where layers of low-permeability rock that impede downward movement are common. Both lateral and vertical flow may be channeled through faults and fractures, but plastic or swelling clays that can seal faults and fractures are abundant. Typically groundwater flow in the Book Cliffs continues both laterally and downward until it intercepts the surface and is discharged as a spring or seep, enters a stream as baseflow, is transpired by vegetation, or simply evaporates. Groundwater tends to flow more readily through shallower systems because the hydraulic conductivities are commonly larger than those of deeper systems, but some of the groundwater will follow slower, deeper flow-paths.

Groundwater in the CIA, as is typical of groundwater throughout the Price River basin, occurs under both confined and unconfined conditions. In the CIA, the Blackhawk Formation, Castlegate Sandstone, Price River Formation, North Horn Formation, Flagstaff Limestone and Quaternary deposits all contain potential perched aquifers or conduits for groundwater. Aquifer lithologies are predominately sandstone and limestone. Sandstone aquifers occur where there is sufficient intergranular porosity and permeability in lenticular fluvial-channel and tabular overbank deposits, whereas limestone aquifers have developed through dissolution and fracturing of tabular lacustrine deposits. Shale, siltstone, and cemented sandstone beds act as aquatards or aquacludes to impede groundwater movement. The Mancos Shale is a regional aquaclude that limits downward flow. More localized aquatards occur within the North Horn, Price River, Castlegate and Blackhawk Formations.

Generally springs in the Book Cliffs and Wasatch Plateau coal fields are associated with contacts between zones or strata of differing permeability, such as at the base of sandstone lenses in the Colton and Green River Formations or limestone beds in the Flagstaff and North Horn Formations (Osterwald and others, 1981). In many areas, such as the Soldier and Dugout Canyon area several miles to the northwest, the contact between the Flagstaff Limestone and the North Horn Formation is the preferred location for springs; however, in the CIA there are only a few springs at this contact because the Flagstaff Formation is thin or absent and the contact between the Flagstaff and North Horn Formations is transitional (Osterwald and others, 1981), and in addition the overlying Colton Formation is relatively thick.

Springs or areas of multiple springs are or have been monitored within the West Ridge CIA by West Ridge Resources, Inc. and its predecessors. In the fall of 1985 and spring of 1986 a seep and spring survey was done on West Ridge by Kaiser Coal Corporation to evaluate the density, or spatial distribution, of springs between a mined-out area and an area that had not been mined. Approximately 150 seeps and springs were identified (West Ridge Mine MRP, Appendix 7-1). Additional data on some of the springs in the 1985-86 survey were collected by Kaiser Coal Company in 1988 and 1989.

The seep and spring density was found to be roughly the same in both areas: the mined out area had a density of 21.1 springs and seeps per square mile producing an average of 74.8 gpm/sq mi compared with 22.4 springs and seeps per square mile in the unmined area, producing an average of 79.3 gpm/sq mi. This information indicates that subsidence from mining in the existing Sunnyside Mines had produced no quantifiable difference in flow of seeps and springs on the west side of Whitmore Canyon.

In the CIA the large majority of the seeps and springs occur in Whitmore Canyon where they issue from the Colton Formation and alluvium and colluvium (Maps 6-1 and 7-5 and Figure 10 of the West Ridge MRP). The number of springs decreases rapidly downward through the stratigraphic section. Mayo and Associates (1998, p. 59) identified 83 springs issuing from the Colton, 29 from the North Horn, 11 from the Price River, and 1 from the Mancos. There were 29 from alluvium or colluvium, but none were identified as flowing from the Castlegate Sandstone or Blackhawk Formation. Several of the springs identified in the Kaiser surveys as discharging from the Castlegate Sandstone (S-40 and S-84) and Blackhawk Formations (S-2, S-20, S-62, and S-81) were grouped by Mayo and Associates with the alluvial and colluvial springs. Even if seeps and springs do not discharge from the Castlegate Sandstone and Blackhawk Formation in this area, there are permeable horizons in these units that contain groundwater; the drillers log for DH86-2 shows groundwater was encountered in the upper Blackhawk Formation during drilling (Mayo and Associates, 1998, p. 60), and the well is currently used to monitor groundwater in the Sunnyside Sandstone Member.

The large alluvial fan at the mouth of Whitmore Canyon is a valuable source of water for the Sunnyside area. It is recharged from Grassy Trail Creek. Springs and wells in this fan provide water for irrigation, domestic and industrial uses, and livestock. With the addition of federal lease UTU-78562, stream monitoring sites ST-9 and ST-10 were added to the Operational Monitoring Plan to monitor any changes in the flow of Grassy Trail Creek above the Grassy Trail Reservoir. ST-9 is located at the inlet of Grassy Trail Reservoir and ST-10 is located at the northern boundary of the federal lease where it intersects Grassy Trail Creek.

Test holes were bored from the surface and from within Kaiser's exploratory entries. West Ridge Resources reported that the drill-hole logs contain no information about groundwater encountered during drilling. It is unknown if water was not encountered or if groundwater was simply not noted on the logs; however, groundwater has been monitored in drill-holes DH 86-1 and DH 86-2, and DH 90-1 has been used as a water-supply well, so it is likely that groundwater was encountered in other bore holes also.

Information on hydraulic conductivities in strata beneath or near the coal seams can be inferred from measurements done at the nearby Soldier Canyon Mine. Three bore holes were drilled from the Rock Canyon seam workings of the Soldier Canyon Mine down through the Gilson seam and a 13- to 20-foot thick, clean sandstone located approximately 40 to 50 feet below the Gilson seam. Hydraulic conductivities of $2x10^{-7}$ to 10^{-6} cm/sec were measured in two of the holes , but hydraulic conductivity was $1.5x10^{-3}$ cm/sec in the third. The tests measured the hydraulic conductivity of the entire stratigraphic sequence. Groundwater was under confined and flowing conditions in all three bore holes. Even assuming the bore holes measured the hydraulic properties of the same stratigraphic sequence at the three different locations, the range of hydraulic conductivities shows great non-homogeneity and indicate that any potentiometric surfaces in strata beneath the coals are almost certainly not planar or of uniform dip. Information on these three bore holes, including drillers logs, is in Appendix 7-I of the Soldier Canyon Mine MRP.

Sunnyside City and East Carbon City have water right 91-4960 for 31.621 ac-ft/yr (19.6 gpm) from water-supply well DH 90-1 in the SW1/4 SW1/4 of Section 17, T. 14 S., R. 14 E. Information from the state engineers office in Price (Mark Page, DWR, Personal Communication to West Ridge Resources) indicates that the well has a total depth of 500 feet. The well has a gravel pack from 207 to 500 feet below ground surface. According to information from the Sunnyside Coal Company that is cited in the West Ridge Mine MRP, DH 90-1 is completed in the Price River and North Horn Formations. Because the well is located over a mile from the West Ridge Mine lease boundary, and is completed in the Price River and North Horn Formations, it is very unlikely that mining in the permit area will affect groundwater systems that contribute water to DH 90-1.

Mine Inflow

Most water entering mines in the Wasatch Plateau and Book Cliffs coal fields comes through leaks in the mine roof. Historic discharges from the nearby Soldier Canyon and Sunnyside Mines average about 300 to 400 gpm. Average annual flow into the Soldier Canyon Mine between 1988 and 1994 was approximately 420 gpm, and water not used in the mine or lost to evaporation is collected in an in-mine settling pond and discharged to Soldier Creek through a Utah Pollutant Discharge Elimination System (UPDES) permitted discharge point. Mine discharge rates in 1985 and from 1987 to 1996 varied from less than 100 gpm to over 700 gpm and averaged about 400 gpm. Both discharge rates and coal production increased slightly over the seven-year period from 1987 to 1994; however changing water management practices and measurement errors rather than variations in flow into the mine could be contributing to or be entirely responsible for the variations observed.

Groundwater quality varies greatly, depending on geology, physiography, and elevation. Waddell and others (1986) indicate that TDS concentrations range from 250 to 2,000 mg/L in the Book Cliffs area. The best quality occurs in or near mountain recharge areas and the poorest quality in lowland areas. The chemical characteristics of the groundwater vary vertically from formation-to-formation and aerially within each formation. TDS in water from the Flagstaff Limestone ranges from 250 to 500 mg/L, whereas TDS in the Blackhawk and North Horn Formations range from 500 to 2,000 mg/L. The principal chemical constituents in Flagstaff water are calcium and bicarbonate. Water from the Blackhawk is of variable chemical composition with no single dominant cation or anion. Where dissolved solids concentrations from water in the Blackhawk are affected by the Mancos Shale, sulfates of sodium and magnesium increase significantly. Mundorff (1972) and Waddell and others (1986) reported that water f rom two springs that issue near the contact between the Blackhawk Formation and the Mancos Shale have specific conductances that indicate TDS concentrations of 1,600 and 2,000 mg/L, respectively.

Water samples collected from several locations inside the Sunnyside Mine, in particular sumps, consistently had TDS levels in excess of 1,200 mg/L. Many of the samples from areas other than sumps had better quality water with TDS levels between 400 to 800 mg/L, which is probably more representative of the groundwater that was flowing into the mines. TDS levels in drill hole DH-86-1 were also in this 400 to 800 mg/L range, but 15 of 17 samples from DH-86-1 were above 1,200 mg/L TDS. Well DH-86-1 has not been monitored since August 1996. At that time, numerous attempts were made to monitor the well, but the well was blocked/breached at approximately 450-ft below the ground. The well is screen from the 575-657 foot level. Waters from springs SP-6, SP-8, and PC-1 also are high in TDS.

Saturation indexes indicate that most groundwaters are at saturation with respect to calcite. Groundwaters are generally undersaturated with respect to dolomite, gypsum, and anhydrite (Waddell and others, 1986).

In the West Ridge Mine, little water was encountered before 2003. Water needed for mine operations was acquired from the City of East Carbon and piped to the mine facilities. In February 2003, groundwater inflow increased as mining progressed and excess water was discharged directly to C Canyon under a UPDES permit (UPDES outflow #2). As shown in Figure 1, the mine operator reported the daily average discharges for each month ranging from 1 to 194 gpm from February 2003 through December 2004 (DWQ DMRs and UDOGM electronic database). Based on these daily average discharge rates, the total yearly discharge is calculated to be approximately 200 and 210 acre-feet for 2003 and 2004, respectively. Daily average discharge has increased to between 240 and 350 gpm in the first quarter 2005.

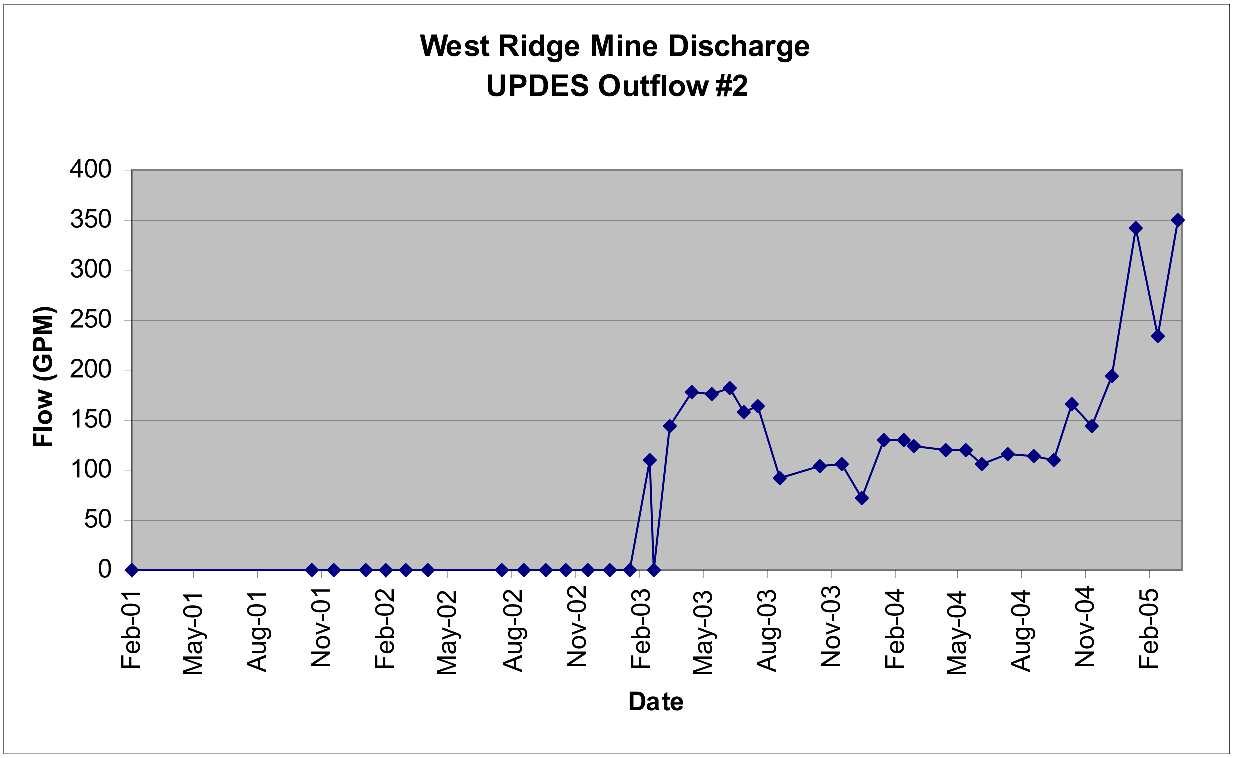

Figure 1

According to the West Ridge Mine MRP (Appendix 7-7), it is estimated the mine uses 21,804,600 gallons or about 67 acre-feet per year, which includes evaporation from ventilation, washdown, culinary uses, and what would be used by the longwall, continuous miner, and roof bolter. When mining began, most of the water required for operations was acquired from the City of East Carbon. As mining progressed and more water was encountered, less water was imported to the mine workings as mine inflows were used for some of the operation needs. However, some culinary water is still needed for mine operations. The estimated volume of water discharged through ventilation (evaporation) is reported to be 16 gpm (8.4 million gallons per year (MG/yr)). The percentage of moisture in the coal hauled from West Ridge is 6.4% (4.4% inherent coal moisture plus 2.2% added moisture for dust suppression and processing) (pers. com. Gary Gray, West Ridge Resources, Inc.). Based on the 6.4% moisture content, the volume lost due to coal moisture content is approximately 15.3 gallons per ton.

Table 2 shows the estimated groundwater discharge due to outflow, evaporation, and extraction (coal moisture content) for the West Ridge Mine. Extraction quantities are calculated based on the production volumes reported for the West Ridge Mine by MSHA (Table 1). Total estimated discharge has increased from 50.6 ac-ft in 2000 to 365.8 and 342.4 ac-ft in 2003 and 2004, respectively, as outflow and production volumes have increased. The actual discharge values are likely less than estimated since some culinary water is piped into the mine for operation purposes (pers. com. Dave Shaver, West Ridge Resources, Inc.).

Estimated Annual Groundwater Discharge West Ridge Mine					
Year	UPDES Outflow #2 MG	Evaporation MG	Extraction MG	Total MG	Total ac-ft
2000	0	8.4	8.1	16.5	50.6
2001	0	8.4	35.1	43.5	133.5
2002	0	8.4	43.4	51.8	158.9
2003	65.2	8.4	45.6	119.2	365.8
2004	68.4	8.4	34.8	111.6	342.4

MG = million gallons; ac-ft = acre-feet

Table 2

Surface Water

The CIA is situated in the Book Cliffs, about halfway between the headwaters of the Price River and its confluence with the Green River (Plate 1). Many streams that originate in the Book Cliffs are perennial at higher altitudes, but become ephemeral as they emerge from the mountains and flow onto the lowlands (p. 7 in Waddell and others, 1981). The CIA is drained directly by Grassy Trail Creek through Whitmore Canyon (Figure 3 and Plate 1) and by several small ephemeral or intermittent creeks that drain the western face of West Ridge and flow westward toward lower Grassy Trail Creek. Grassy Trail Creek is perennial above and for a short reach below Grassy Trail Reservoir, but intermittent from the Sunnyside area to its confluence with the Price River. The Price River flows into the Green River about 40 miles southeast of the mines (Plate 1). The Green River flows southward from its confluence with the Price River approximately 75 miles until it discharges into the Colorado River.

Flow in the Price River is regulated at Scofield Reservoir, and discharge is measured at several locations both upstream and downstream of the confluences with Deadman, Coal, Soldier, and Grassy Trail Creeks. The area of the Price River drainage is 455 mile^2 above USGS gauging station 09313000 near Helper, and 1,540 mile^2 above USGS streamflow gauging station 09314500 near Woodside, about 10 miles below the confluence with Grassy Trail Creek. Between these two stations water is taken from the river and its tributaries for irrigation.

As of 1997, USGS water discharge data are available for station 093143000 for water years 1934 to 1969, 1979 to 1981, and 1990 to 1996. Records are fair except for estimated daily discharges, which are poor.[1] Extreme flows recorded were 9,340 cfs on September 13, 1940 and 0.4 cfs on August 21, 1961. The mean annual flow volume for the three periods of record is 110 cfs or 80,000 ac-ft/year.

USGS water discharge data are available for station 09314500 for water years 1909 to

[1] 'Good' means about 95 % of reported daily discharges are within 10 % of the actual discharge, 'fair' means within 15 %, 'poor' means reported values have less than 'fair' accuracy. Accuracy is based on 1) the stability of the stage-discharge relationship or, if the control is unstable, the frequency of discharge measurements; and 2) the accuracy of observations of stage, measurements of discharge, and interpretation of records.

1911 and 1945 to 1992. Records are fair except for estimated daily discharges, which are poor. Maximum recorded discharge was 11,200 cfs on September 7, 1991. Periods of no flow were recorded in 1960, 1961, 1963, and 1992. The mean annual flow volume (1947 to 1992) was 121 cfs or 88,000 ac-ft/year. Limited water quality data are available for 1946 to 1949, 1951 to 1988, and 1991 to 1996 (Table 3).

Discharge of the Green River has been measured at USGS gauging station 09315000 at Green River, Utah, about 12 miles below the confluence of the Price and Green Rivers. For water years 1894 to 1899 and 1904 to 1996 flow ranged from a minimum of 255 cfs on November 26, 1931 to a maximum of 68,100 cfs on June 27, 1917. Average annual discharge is 6,192 cfs or 4,484,000 ac-ft/year. Records are good except for estimated daily discharges, which are poor. Water quality data are available for 1928 to 1996 (Table 3).

Snowmelt is the major source of water for the perennial streams of the Price River basin. Intermittent and ephemeral streams are abundant, existing primarily at lower elevations where potential evapotranspiration exceeds precipitation. Intense summer thunderstorms may cause short-term flooding, but not large volumes of runoff.

Water use in the higher elevations of the Price River basin is primarily for wildlife and stock watering purposes. The upper watershed provides most of the domestic water needs for the lower valley. Within the lower valley area, agricultural activities utilize some of the water (Mundorff, 1972). Minimum flows in the gauged streams and rivers in the basin occasionally reach zero. Storage reservoirs are common at higher elevations.

In general the quality of water in the headwaters of the Price River basin is excellent. Waddell and others (1981) report that the Price River and its tributaries generally have a TDS concentration of between 250 to 500 mg/L upstream from Helper, and the water type in this area is calcium bicarbonate. However, the quality of water in the Price River rapidly deteriorates down gradient. Below the town of Helper most flows originate on Mancos Shale or are irrigation return flows from lands situated on Mancos-derived soils (Price and Waddell, 1973). The Price River near the confluence with Soldier Creek has an average TDS content of about 1,700 mg/L, including sulfates of calcium, magnesium and sodium. At USGS station 09314500, the weighted average TDS content is between 2,000 and 4,000 mg/L, with the water type being strongly sodium sulfate (Mundorff, 1972).

Sediment yields from the upper portion of the Price River basin are small, with erosion rates varying from 0.1 to 0.5 ac-ft/mile^2/yr. Lowest rates are from the higher parts of the Book Cliffs, where exposed rocks are dominantly limestone and dolomite. The bulk of the sediment in the Price River comes from the more erodible sandstones and shales that are common at lower elevations, where annual sediment yields of 0.5 to 3.0 ac-ft/mile^2/yr are reported by Waddell and others (1981, Plate 6).

Surface Water Hydrology of the CIA

The Book Cliffs III CIA covers approximately 31,000 acres of Whitmore Canyon and several small ephemeral and intermittent watersheds on the west side of West Ridge.

Topography in the area is rugged, with elevations ranging from approximately 6,000 to over 9,000 feet. Slopes vary from vertical cliffs to less than 2 % along the ridges.

Water resources within or adjacent to the West Ridge CIA include a few low yielding springs and streams. With the exception of Grassy Trail Reservoir, there are no major water bodies located within or adjacent to the CIA.

Soil cover varies with slope, with bare sandstone cliffs along the upper portions of the canyons, shallow silty soils on the milder slopes, and shallow sand-gravel alluvium in the channel bottoms. The USDA soil survey for the Carbon area (USDA, 1988) indicates the soils along West Ridge are in hydrologic soils groups B to D, having infiltration rates that are moderate to very slow.

The estimated average annual sediment yield is 0.1 to 1.0 ac-ft/mile^2/yr across the CIA. Generally, steep slopes and higher elevations are 0.1 to 0.2 ac-ft/mile^2/yr while lower, flat areas developed on Mancos Shale are 0.5 to 1.0 ac-ft/mile^2/yr (Waddell and others, 1981, Plate 6), so the estimated average annual sediment yield of the CIA covers a broad range, 5 to 48 ac-ft/yr for undisturbed conditions.

Grassy Trail Creek

The headwaters of Grassy Trail Creek are in the area between the Book Cliffs and the Roan Cliffs in the north part of the CIA (Plate 2), at altitudes ranging from approximately 7,000 to over 9,000. Whitmore Canyon, a steep, deep, narrow valley, has been eroded through Tertiary and Cretaceous strata. At the mouth of Whitmore Canyon, Grassy Trail Creek crosses a large alluvial fan then meanders across a gently sloping plain on the Mancos Shale to its confluence with the Price River. USGS monitoring station 09314340 is located at an elevation of 6,600 feet, approximately half way between the town of Sunnyside and the Sunnyside Mine. According to Mundorff (1972), Grassy Trail Creek has the largest drainage area of any tributary to the Price River. The drainage area above station 09314340 is 40.1 miles^2 (USGS, 1998), and from topographic maps it can be determined that the length of the stream is approximately 10 miles and has a slope of roughly 230 feet/mile.

The USGS measured discharge of Grassy Trail Creek for water years 1979 to 1985 at station 09314340 (USGS, 1998); record quality was good. Typically, most of the total flow in the Book Cliffs is from snowmelt, but highest flows are from thundershowers. Grassy Trail Creek average daily mean discharge for the seven-year period was 9.9 cfs (Figure 2). Maximum daily mean flow was 349 cfs on May 28, 1983 and maximum measured flow was 631 cfs on May 31, 1983. Minimum daily mean flow was 0.04 cfs on February 22, 1981, and no flow was observed at some time during the day on several days in February 1981.

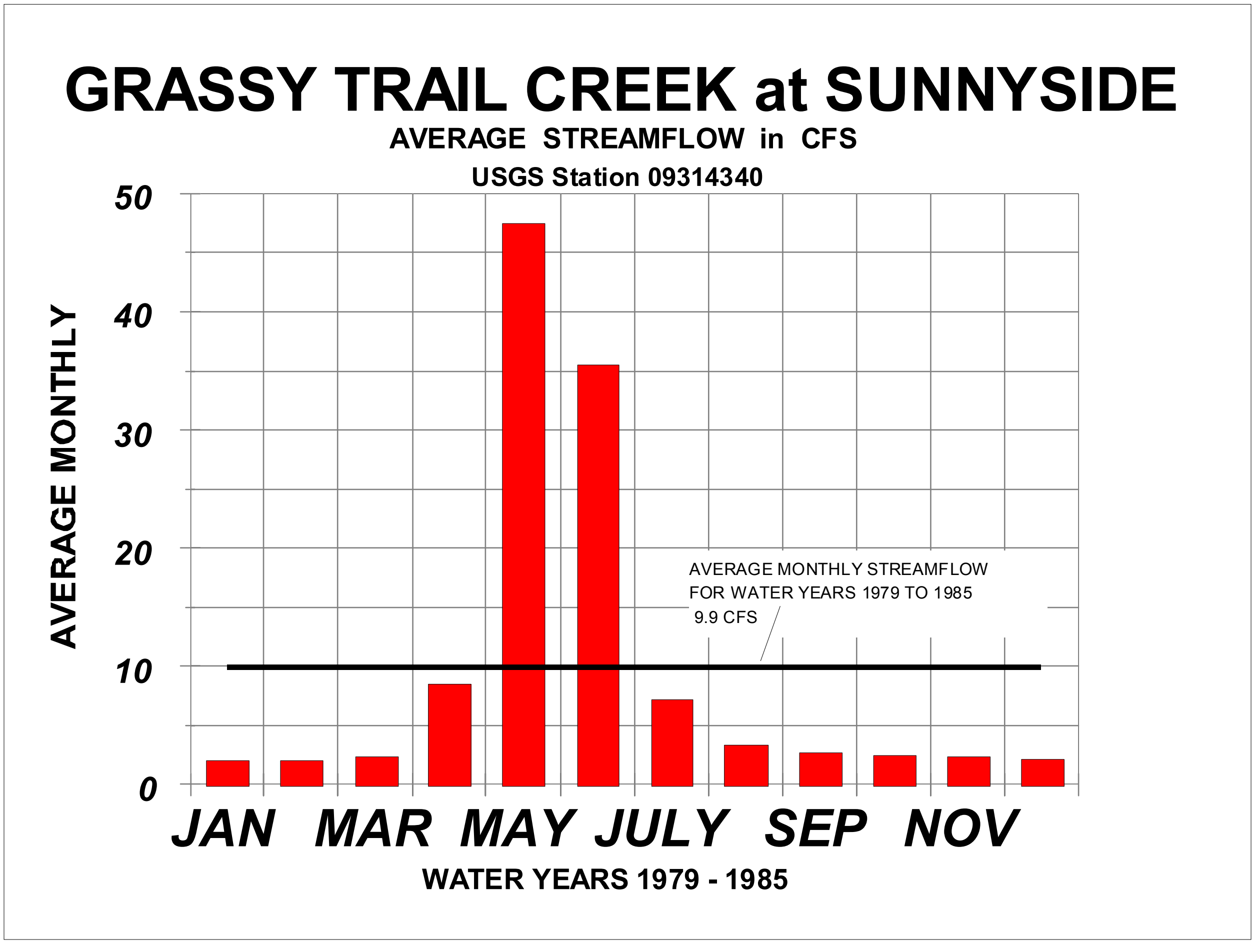

FIGURE 2

Baseflow measurements (Price and Plantz, 1987) in water years 1979 to 1984 indicate that flow increases substantially between Grassy Trail Reservoir and station 09314340. Although much of the increase was attributed to discharges from the Sunnyside Mine, some was due to groundwater inflow from the Price River Formation and overlying strata.

Water quality was measured in up to 49 samples (not all samples were analyzed for all parameters) from station 09314340 during water years 1979 to 1984. TDS ranged from 330 to 1,900 mg/L, with a mean value of 988 mg/L. In general, dominant cations were calcium and magnesium and dominant anions were bicarbonate and sulfate; however, there were seasonal variations that related directly to TDS, which was related to streamflow and mine discharges (Price and Plantz, 1987). In 12 samples analyzed for lead, maximum concentration was 55 µg/L, which is above the Utah Division of Water Quality (UDWQ, 1994) criteria of 50 µg/L for aquatic wildlife and domestic water sources. Eight samples were analyzed for mercury, with mercury concentrations ranging from below the detection limit of 0.1 µg/L up to 1.4 µg/L, which all fall below the UDWQ criteria of 2 µg/L for Class 1C and 2.4 µg/L for Classes 3A-3D waters; however, some exceeded the criteria for the protection of human health of 0.144 µg/L.

Phenols come from natural organic sources, but can also be indicators of polluting effluents from industrial processes, including coal mining. The limit for Class 1C waters for the protection of human health is 300 µg/L, but for aquatic wildlife (Classes 3A-3D) the limit is only 10 µg/L (UDWQ, 1994). For many species of fish 5 µg/L has been reported to be harmful (Waddell and others, 1981). The detection limit for the twenty phenol analyses reported was 40 µg/L (Price and Plantz, 1987), so phenol levels may have exceeded water quality standards for aquatic wildlife without being detected.

Suspended sediments in 25 samples ranged from 4 to 1,640 mg/L. The largest calculated instantaneous sediment load was 518 tons/day. The sampled sediments were about 17 % coal, with water discharged from the mines being the probable source (Price and Plantz, 1987).

Price and Plantz (1987) reported good benthic-invertebrate diversity. In the five phytoplankton samples collected in 1981, green algae had a uniform distribution, but blue-green algae had relatively larger numbers in three.

Monitoring of Grassy Trail Creek by Sunnyside Mines showed that from 1989 through 1992, when sampling ceased, TDS consistently exceeded 1,200 mg/L at GT-4, located between the Sunnyside Mine and the town of Sunnyside. During this same period TDS concentrations also increased at GT-2 and GT-3, monitoring sites upstream of the main mine area (Figure 3). This does not appear to have been solely due to road salting because concentrations of all ions increased more-or-less uniformly.

SUMMARY OF SELECT WATER QUALITY DATA FROM USGS STATIONS PRICE RIVER AT WOODSIDE AND GREEN RIVER AT GREEN RIVER UTAH

STATION NUMBER	STATION NAME	WATER YEAR		SPECIFIC CONDUCT-ANCE (micro-mohs)	pH (units)	TEMPER-ATURE (deg. C)	DIS-SOLVED SOLIDS RESIDUE at 180 deg. C	CAL-CIUM Ca	MAG-NESIUM Mg	SOD-IUM Na	POTA-SIUM K	CHLO-RIDE Cl	SUL-FATE SO_4	BI-CARBONATE HCO_3	IRON TOTAL Fe	IRON DISSOLVED Fe	MANGANESE TOTAL Mn	MANGANESE DISSOLVED Mn	SUSPENDED SEDIMENT
09314500	Price River at Woodside	1975-76	Min.	2,200	8.2	0	1.070	170	85	230	7.0	31	1,000	260	-	-	-	-	-
			Max.	4,950	8.0	26.5	4,830	310	250	730	12.0	78	2,000	330	-	-	-	-	-
		1976-77	Min.	1,370	7.4	0	1,150	220	16	77	7.0	15	600	170	440	10	-	8	17
			Max.	6,950	8.7	29.0	6,770	400	350	1,100	15.0	130	4,300	570	510,000	70	16,000	110	69,400
		1977-78	Min.	1,140	7.6	0	1,290	110	79	190	4.0	22	640	40	10	10	90	10	27
			Max.	6,090	8.7	26.0	4,990	330	290	760	13.0	100	3,100	450	18,000	20	860	60	4,420
		1978-79	Min.	1,110	8.0	-	822	83	51	110	3.4	17	390	240	280	-	10	-	16
			Max.	6,540	8.4	21.5	6,240	250	320	990	17.0	110	3,700	500	46,000	-	1,300	20	5, 560
		1979-80	Min.	1,090	8.0	0	761	-	-	-	-	-	-	270	-	0	-	-	93
			Max.	5,510	8.7	23.0	5,660	-	-	-	-	-	-	$20	63,000	-	2,600	10	12,200
		1980-81	Min.	2,720	8.0	0	2,070	130	130	300	7.2	52	1,300	160	-	-	-	-	0
			Max.	4,480	8.3	24.0	3,860	250	230	640	12.0	96	2,500	330	-	-	180	-	5,200
		1981-82	Min.	1,170	8.0	0	830	82	53	97	2.9	16	360	194	9,600	-	240	-	150
			Max.	4,080	8.3	23.5	2,880	240	210	530	8.9	90	2,100	350	24,000	-	820	-	23,000
		1982-83	Min.	830	8.2	0	830	82	53	97	2.3	17	210	210	-	-	-	-	110
			Max.	3,920	8.4	20.0	3,500	260	220	520	8.9	79	2,200	340	36.000	-	960	-	12,000
09315000	Green River at Green River	1975-76	Min.	450	8.1	0	276	41	19	30	1.0	7.7	110	150	570	0	30	0	32
			Max.	1,030	8.7	26.0	704	82	35	110	3.3	35	300	270	32,000	60	1,000	20	3,403
		1976-77	Min.	530	7.7	0	335	49	15	44	2.1	15	150	160	1,300	0	30	0	-
			Max.	1,520	8.7	29.0	1,210	190	43	110	7.0	33	670	300	330,000	190	7,600	20	18,300.
		1977-78	Min.	300	7.9	0	212	33	13	33	1.0	7.1	69	190	1,700	10	50	0	95
			Max.	1,070	8.5	28.5	756	81	39	120	3.5	38	350	270	21,000	40	630	10	13,400
		1978-79	Min.	300	8.0	0	273	35	15	29	-	8	86	-	830	0	40	0	49
			Max.	1,240	8.5	28.0	852	87	42	110	9.5	41	390	330	19,000	120	500	8	47,500
		1979-80	Min.	320	7.6	0	214	29	12	21	1.5	7.4	70	130	2,000	<10	50	1	60
			Max.	1,310	8.5	27.0	798	85	37	110	5.0	38	410	260	39,000	40	1,100	10	11,600
		1980-81	Min.	320	7.8	0	273	47	19	50	1.8	14	160	110	1,200	<10	40	1	19
			Max.	1,200	8.3	26.0	852	82	41	110	3.7	40	350	190	27,000	30	880	10	5,760
		1981-82	Min.	290	8.0	0	196	29	10	19	0.6	6	60	90	10,000	5	210	<1	134
			Max.	1,060	8.4	27.5	749	82	40	100	3.3	37	320	180	31,000	20	840	6	16,700
		1982-83	Min.	400	8.0	0	494	30	15	29	-	9.3	98	111	-	6	-	3	64
			Max.	960	8.4	25.0	584	69	32	76	-	25	270	104	-	31	-	130	5,650

Notes: Station locations: See Figure 4 (Price River Drainage Basin. Constituents : in mg/L, except manganese and iron, which are in micrograms/L. Specific Conductance: field determinations. pH: field determinations.

Table 3

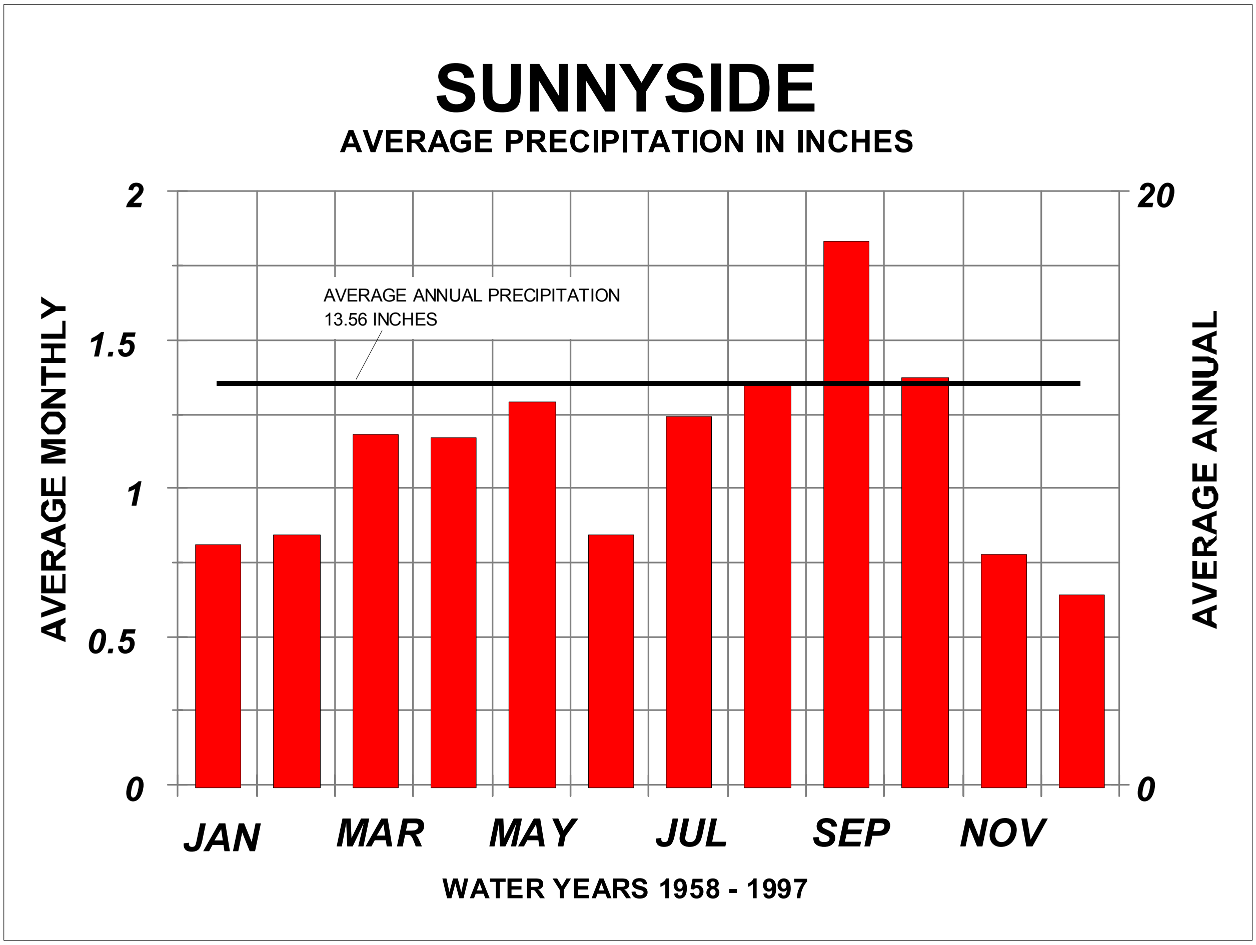

FIGURE 3

CLIMATOLOGICAL INFORMATION

The CIA is located in the northwestern portion of the Price River basin in eastern Utah. The basin in surrounded almost completely by mountains, with elevations of over 9,000 ft. in the CIA. The mountains greatly influence local weather, inhibiting cold arctic air masses from penetrating into the region and acting as a barrier to storms approaching from every direction except south. Clear days predominate.

Daily climatic information is collected at a National Weather Service station in Sunnyside, Utah. Mean monthly precipitation at Sunnyside is shown in Figure 7. Average annual precipitation is 13.56 inches. The area typically receives the greatest quantity of moisture from thundershowers in the late summer and early fall (August-October). The driest months at Sunnyside are November to February. Average annual precipitation in the area around the West Ridge Mine ranges from approximately 8 inches along lower Grassy Trail Creek to 16 inches on West Ridge and in upper Whitmore Canyon (Mundorff, 1972, Plate 2).

In the Price River basin as a whole, approximately 65% of total precipitation at elevations above 6,000 feet falls as snow during the period from October to April (Mundorff, 1972). At the

West Ridge site average annual snow accumulation is about 1 foot, but varies with elevation, topography, and aspect. At the mouth of Whitmore Canyon (elevation 6,750 feet) snow accumulations range from 0 to 21 inches during October through March, but at 7,280 feet snow accumulations ranged from 0 to 50 inches. Monthly maximum, mean maximum, and mean daily snow accumulations for the years 1973 through 1983 are in Table 4. Ground accumulations of snow are characteristically of short duration due to melting and sublimation (Chapter 4 of the West Ridge MRP). Average annual snowfall from 1958 to 1988 at the Sunnyside Mine, approximately elevation 6,800 feet, was 38 inches (Ashcroft and others, 1992).

SNOW ACCUMULATION IN INCHES, 1973-1983
SUNNYSIDE MINE
(approximately 6,800 foot elevation)

	Maximum	Mean Maximum	Mean Daily
October	6.5	1.35	0.73
November	6.0	1.69	0.28
December	14.00	4.42	1.73
January	21.00	9.86	4.01
February	21.00	6.44	2.84
March	15.00	5.30	0.60

Table 4

Measured evapotranspiration in the Sunnyside area is 41 to 43 inches (Ashcroft and others, 1992). In Chapter 4 of the West Ridge MRP it is reported that Sunnyside Coal Company estimated potential evaporation to be over 60 inches.

Temperature ranges of the CIA are typical for a semi-arid region, with colder temperatures at higher elevations. At the Sunnyside Mine (1958 to 1988) average maximum temperature was 58 degrees, average mean was 46, and the average minimum was 33 degrees. Average monthly temperatures ranged from about 14^{o} F in January to about 85^{o} F in July. Last freeze is typically in late May and first freeze in late September to early October (Ashcroft and others, 1992).

The Palmer Hydrologic Drought Index (PHDI) indicates long-term climatic trends for the region. The PHDI is a monthly value generated by the National Climatic Data Center (NCDC) that indicates the severity of a wet or dry spell. The PHDI is computed from climatic and hydrologic parameters such as temperature, precipitation, evapotranspiration, soil water recharge, soil water loss, and runoff. Because the PHDI takes into account parameters that affect the balance between moisture supply and moisture demand, it is useful for evaluating the long-term relationship between climate and groundwater recharge and discharge. Figure 4 shows the Palmer Hydrologic Drought Index for Utah Divisions 6 and 7; the permit area lies at the boundary of these two regions. These graphs indicate extremely wet years between the late

1970's and late 1980's, followed by several years of drought in the late 1980's and early 1990's. Since about 1993, wet and dry cycles have been shorter until the extended drought period from 1999 through fall 2004.

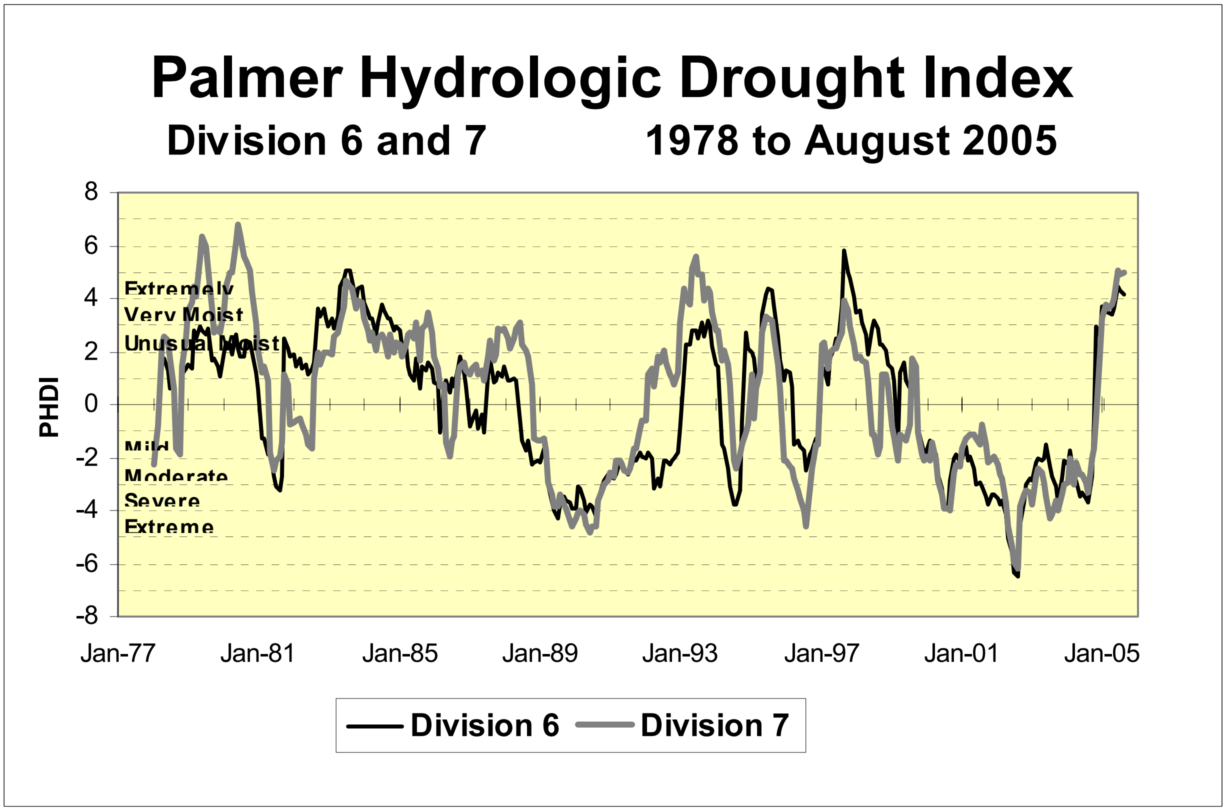

FIGURE 4

Wind

Wind data were collected by Sunnyside Cogeneration Associates (SCA) during 1982 and 1983 for permitting of the SCA power plant (the applicant for the West Ridge Mine permit obtained these data from the 1993 Sunnyside Coal Company MRP). The SCA data, collected near East Carbon from atop a 45-meter tower, show that the majority of the winds are from the north-northeast through the south-southwest (clockwise) with an average annual speed of 6.2 mph.

Upper level winds, over 1,600 feet above the ground level, are generally from the southwest during most of the year. The wind high in the atmosphere tend to be strong but decease toward the surface where obstructions and surface friction come into play. During the winter, air flow from the northeast is common. Local night airflow patterns are primarily follow canyon bottoms from the mountains down to the valleys, and wind speed is induced by decent of colder air and is generally light. Daytime flow is strongly influenced by surface heating effects that result in mixing between the surface and upper flows. There is a general air flow toward the north and northeast (to higher elevations) during the day, and toward the southwest (toward lower elevations) during the night. Winds are usually light to moderate (below 20 mph) unless influenced by localized thunderstorms or moving frontal systems. Higher wind speeds are generally associated with storm systems and higher elevations such as ridge tops and plateaus (Chapters 4 and 7 of the West Ridge MRP).

IV. IDENTIFY HYDROLOGIC CONCERNS

The CHIA is based on the best currently available data and is a prediction of mining related impacts to the hydrologic balance outside of the specific permitted coal mine areas. To verify that conditions remain within acceptable limits the mine operator is required to monitor water quality and quantity as part of the permit requirements. The plans for monitoring are set forth in the MRP for the West Ridge Mine and have been determined adequate by UDOGM to meet regulatory requirements. If monitoring results show significant departures from the values established in the MRP and in this CHIA or exceed UPDES discharge requirements, immediate remedial actions are provided for by SMCRA.

SUBSIDENCE

Subsidence impacts are largely related to extension and expansion of existing fracture systems and upward propagation of new fractures. Inasmuch as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjustment or realignment in the conduit system will inevitably produce changes in the configuration of groundwater flow. Potential changes include increased flow rates along fractures that have "opened", and diverting flow along new fractures or within permeable lithologies. Increased flow rates along fractures would reduce groundwater residence time and potentially improve water quality. Subsurface flow diversion may cause the depletion of water in certain localized aquifers and potential loss of flow to springs that will be undermined.

Subsidence due to mining in the Lower Sunnyside Seam is expected to be similar to that which has been experienced at the Sunnyside Mine and previous mining at the West Ridge Mine. Mining in the area has been by both room-and-pillar and longwall methods, and both will be used in future mining. Due to the 1,000 to 2,500 foot depth of cover throughout much of the West Ridge Mine permit area, surface cracks are not common at West Ridge. Subsidence is likely only over longwall panels, over room-and-pillar areas where second mining is done, and in surrounding areas within the expected angle-of-draw.

Because of the thin interburden beneath portions of the Right Fork of Bear Creek (approximately 325 feet at the shallowest point beneath Bear Creek), the PHC determination has been updated for the addition of State Leases ML 49287 and ML 47711. The PHC references Peng, 1978, stating that in longwall mining, subsidence-related fractures can be expected to propagate for a distance above the coal seam equal to 50 times the mining height (approximately 316 feet in the Bear Canyon area). Because of the shallow interburden and the possibility for subsidence-related fractures to reach the surface from the mine, West Ridge has committed to additional monitoring in Bear Canyon.

The additional monitoring consists of three surface monitoring sites in Bear Canyon (ST-13 located below the confluence of the Left and Right Forks of Bear Canyon, and ST-11 and ST-12 located in the Right Fork of Bear Canyon), a subsidence survey and inspection of Bear

Canyon following mining in the area, and a pre-mining detailed vegetation survey of the canyon bottom. West Ridge has also committed to mitigate damage if it is determined that the hydrologic balance in Bear Canyon has been adversely impacted due to subsidence-related fractures. Mitigation will take the form of sealing surface fractures in the stream channel with bentonite or, if bentonite sealing is proven ineffective, by the installation of piping to transport water across fracture zones.

GROUNDWATER

The greatest mining-related potential for impacting groundwater resources in the CIA comes from dewatering and subsidence. Following spring and seep surveys and baseline studies prior to mine permitting, representative springs and seeps are chosen for a mine’s monitoring plan to aid in the determination of mining-related impacts to the hydrologic balance and water rights.

Ten springs and seeps are being monitored within and adjacent to the West Ridge Mine permit area (including two that have been added for baseline monitoring in Spring and Little Spring Canyons in July 2005 for the addition of State Lease ML 47711). Monitoring of springs for the West Ridge Mine has not identified any mining-related impacts and future diversion of spring flow is considered to be at overall low risk.

Emery and Carbon County water users have expressed concerns that water intercepted underground may be discharged into a watershed other than the one where the groundwater was originally destined. According to the Utah Coal Mining and Reclamation Act and rules, a mine may divert water underground and discharge to the surface if material damage to the hydrologic balance outside of a permit area is prevented and disturbance to the hydrologic balance within the permit area is minimized (R645-301-731.214.1). Furthermore, any state-appropriated water affected by contamination, diminution, or interruption resulting from underground mining must be replaced (R645-301-731.530).

The Division evaluates a mine’s Probable Hydrologic Consequences Determination (PHC) and updates the CHIA prior to permitting, and reviews water monitoring data during mining and post-mining reclamation to determine if adverse hydrologic impacts, as defined by the rules, can be demonstrated. Underground mining may result in some diversions of intercepted groundwater into drainages that are not topographically within (above) the area where the water was encountered.

The West Ridge PHC has demonstrated that water that is projected to be intercepted is mostly ancient and therefore hydrologically isolated from springs, seeps, and streams. If it is subsequently demonstrated that the mining has caused or will cause a diminution, contamination, or interruption of an appropriated water right or a material impact to the hydrologic balance either within or outside of the permit area, the Permittee will be required by UDOGM to address means of minimizing the impact and replacing any appropriated water rights.

SURFACE WATER

Increased discharge, especially runoff from disturbed areas, could alter flow volumes, water quality, and runoff and flood patterns in creeks. In addition, subsidence could affect the character of drainages by altering the natural slope of the channel and causing the propagation of fractures at the surface. However, large-scale impacts are unlikely at the West Ridge Mine, because of the thick overburden (typically projected to be from 1,000 to 2,800 feet thick) between the mine operations and the surface drainages.

Full extraction mining is planned under perennial sections of Grassy Trail Creek and Spring Creek (although baseline monitoring of Spring Creek is ongoing and it is yet to be established whether this drainage is perennial or intermittent). Overburden thickness at Grassy Trail Creek and Spring Creek ranges from approximately 1,800 to 2,500 feet. The potential for subsidence cracks to divert water underground is limited by the self-healing characteristics of the formations between the coal seam and surface, which contain interbedded claystones, siltstones, and sandstones that are known to contain hydrophyllic clays (West Ridge Mine PHC). Fractures at the surface are prone to heal rapidly, because of the expanding nature of these clays.

Impacts of full extraction mining beneath perennial streams in the Utah Coal District have been investigated for Burnout Canyon drainage above Canyon Fuel's Skyline Mine. Burnout Canyon is comparable to Grassy Trail and Spring Creeks except that overburden thickness for the latter creeks is over twice the thickness for Burnout Creek. Investigations conducted by Forest Sciences Laboratory, 1998, and Sidel, 2000, indicate that there were no perceptible or quantifiable impacts to Burnout Creek as a result of full extraction mining (USFS, 2001).

Where mining beneath a drainage, the thinnest overburden in the West Ridge permit area is projected to be in the Right Fork of Bear Canyon and B-Canyon. The Right Fork of Bear Canyon and B-Canyon are intermittent and ephemeral drainages, respectively. Where full extraction mining is planned under these drainages, overburden thickness will be approximately 325 feet for a small area, but rapidly thickens upstream, because of the steep dip of the coal seam and the gradient of the stream channels. As stated above, because of the shallow overburden and the possibility for subsidence-related fractures to reach the surface from the mine, West Ridge has committed to additional monitoring and mitigation in Bear Canyon.

Water quality standards for surface waters in the State of Utah are found in R317-2, Utah Administrative Code (UAC). The standards are intended to protect the waters against controllable pollution. Waters, and the applicable standards, are grouped into classes based on beneficial use designations. The Utah Division of Water Quality of the Department of Environmental Quality has classified surface waters in the CIA as:

- 2B - protected for recreational uses except swimming,
- 3C - protected for nongame fish and aquatic life, and
- 4 - protected for agricultural uses.

General hydrologic concerns include changes of flow rates and chemical composition that could physically affect the off-permit hydrologic balance. Changes to the existing hydrologic regime or balance need to be limited in order to prevent economic loss to existing agricultural and livestock enterprises, prevent significant alteration to the channel size or gradient, and maintain adequate capacity for existing fish and wildlife communities. The basis for the limiting value of a parameter may differ according to specific site conditions.

Sediment is a common constituent of ephemeral stream flow in the western United States. The quantity of sediment in the flows affects stream-channel stability and most uses of the water. Excessive sediment deposition is detrimental to existing aquatic and wildlife communities. Large concentrations of sediment in streamflow may preclude use of the water for irrigating crops, because fine sediment tends to reduce infiltration rates in the irrigated fields, and the sediment reduces capacities of storage facilities and damages pumping equipment. Mean sediment load is the indicator parameter for evaluating the sediment hazard to stream-channel stability and irrigation.

The concentration of dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. The quality of water from underground sources reflects the chemical composition of the rocks it passes through. That quality may be degraded by intrusion of poorer quality water from wells or mines, by leakage from adjoining formations, or by recharge through disturbed materials. Water emanating from seeps and springs is used by wildlife and livestock. The state standard for TDS for irrigation of crops and stockwatering (Class 4) is 1,200 mg/L.

Macroinvertebrates are excellent indicators of stream quality and can be used to evaluate suitability of a stream to support fish and other aquatic life. Baseline studies of invertebrates (Lines and Plantz, 1981; and USGS, 1980, 1981, 1982 and 1983) provide standards against which actual conditions in Grassy Trail Creek can be evaluated if desired. Price and Plantz (1987) summarized invertebrate data for Grassy Trail Creek, and Waddell and others (1982) include invertebrate data for nearby Soldier and Pine Creeks.

The Utah Department of Environmental Quality, Division of Water Quality (DWQ) can authorize a coal mine to discharge into surface waters under the Utah Pollutant Discharge Elimination System (UPDES). The West Ridge Mine has a UPDES permit to discharge to Grassy Trail Creek from two points: UPDES point # 1 is located at the principal spillway of the sediment pond, and UPDES point #2 is located near the mine portals at a culvert riser that leads directly into the main bypass culvert. UPDES sample point #2 is to sample water that is discharged directly from the mine into C Canyon.

The West Ridge Mine UPDES permit contains limitations on TDS (one-ton/day), total suspended solids (30-day average, 25 mg/L; 7-day average, 35 mg/L; daily maximum, 70 mg/L), total settleable solids (0.5 ml/L for storm-water discharges), total iron (1.0 mg/L), oil and grease (10 mg/L), and pH (between 6.5 and 9.0). There is no limit on flow, but it is to be measured monthly, and the duration of intermittent discharge is to be reported along with flow. Additionally, there can be no more than a trace amount of visible sheen, floating solids, or foam and no discharge of sanitary waste or coal process water. Monitoring is by monthly grab samples. (Sunnyside Coal Company had an approved UPDES permit with a TDS concentration limit of 1,650 mg/l for the mine water discharge.)

The West Ridge Mine discharge at UPDES outflow #2 has exceeded the permitted TDS limit of 2000 lbs/day for seven months between March 2004 and March 2005. The increased daily maximum load is due to a combination of increased discharge and slightly higher TDS concentrations. The mine has been cooperating with the DWQ to amend their UPDES permit to become compliant. As of August 2005, the West Ridge Mine is applying for an individual UPDES Permit that includes provisions to implement a salinity-offset project.

Utah water quality standards exist for numerous parameters other than those already mentioned above, but at this time there is no evidence or reason indicating they are of concern or have a reasonable potential to affect the hydrologic balance of the CIA. However, those parameters that may have a reasonable possibility of affecting the hydrologic systems are included in routine water quality monitoring of the mine operations. Review of monitoring results by the mine operators and UDOGM will identify concerns or problems and generate revisions of the mine operations to mitigate those problems.

V. IDENTIFY RELEVANT STANDARDS

RELEVANT STANDARDS

Flow: There is no standard for flow in the Utah water quality standards. The West Ridge Mine UPDES permit contains no limit on flow. Discharge is to be measured monthly, and the duration of intermittent discharge is to be reported along with flow. Characteristics such as stream morphology, vertebrate and invertebrate populations, and water chemistry can be affected by changes in flow and therefore can provide an indirect standard for flow.

Oil and Grease: There is no State water quality standard for oil and grease, but the West Ridge Mine UPDES permit limit is a daily maximum of 10 mg/L, which is typical of UPDES permits for coal mines in the Wasatch Plateau and Book Cliffs. Only one grab-sample a month is required to measure oil and grease, but any observation of visual sheen requires a sample be taken immediately. A 10 mg/L oil and grease limit does not protect fish and benthic organisms from soluble oils such as those used in longwall hydraulic systems, and UDWR has recommended soluble oils be limited to 1 mg/L (Darrell H. Nish, Acting Director UDWR, letter dated April 17, 1989 to Dianne R. Nielsen, Director UDOGM).

Total Dissolved Solids (TDS) concentrations: The West Ridge Mine UPDES permit allows up to one-ton per day, to be determined by one grab sample per month. TDS is commonly used to indicate general water quality with respect to inorganic constituents. There is no state water quality standard for TDS for Classes 1, 2, and 3, but 1,200 mg/l is the limit for agricultural use (Class 4). The Soldier Canyon Mine UPDES permit limits instantaneous TDS concentration to 1,200 mg/L, determined by 2 grab samples a month, and the total amount of dissolved solids discharged from all Soldier Canyon Mine operations is limited to 5 tons/day, determined by the twice monthly measurements of flow and TDS. Sunnyside Coal Company had an approved UPDES permit with a TDS concentration limit of 1,650 mg/l for the mine water discharge.

pH: Allowable pH ranges are 6.5 to 9.0 under State water quality standards for all Classes, and also under the West Ridge UPDES permit.

Total Suspended Solids (TSS) and Settleable Solids: the West Ridge UPDES permit has the following allowable limits on TSS: 30-day average, 25 mg/L; 7-day average, 35 mg/L; daily maximum, 70 mg/L. TSS is to be determined by a monthly grab sample. These limits are similar to those at the Soldier Canyon Mine.

There is no State water quality standard for solids in the water, but an increase in turbidity is limited to 10 NTU for Class 2A, 2B, 3A, and 3B waters and to 15 NTU for Class 3C and 3D waters.

Under the West Ridge Mine UPDES permit, all samples collected during storm water discharge events are to be analyzed for settleable solids. Samples collected from increased discharge, overflow, or bypass that is the result of precipitation that does not exceed the 10-year, 24-hour precipitation event may comply with a settleable solids standard of 0.5 ml/L daily maximum rather than the TSS standard, although TSS is still to be determined (and the other UPDES parameters). If the increased discharge, overflow, or bypass is the result of precipitation that exceeds the 10-year, 24-hour precipitation event, then neither the TSS nor settleable solids standard applies.

Iron and Manganese: The West Ridge UPDES permit allows a daily maximum of 1.0 mg/L total iron, determined by a monthly grab sample. The UPDES permit at the Soldier Canyon Mine allows the same daily maximum, but with approval from the Division of Water Quality up to 2 mg/L total iron can be discharged under certain circumstances, which include maintaining dissolved iron at or below 1 mg/L. State water quality standards allow a maximum of 1,000 µg/L dissolved iron in Class 3A, 3B, 3C, and 3D waters, with no standard for Class 1, 2, and 4 waters.

Monitoring of total manganese is required by SMCRA and the Utah Coal Mining rules, but there is no UPDES or Utah water quality standard for either total or dissolved manganese.

Macroinvertebrates: Macroinvertebrates are excellent indicators of stream quality and can be used to evaluate suitability of a stream to support fish and other aquatic life. Baseline studies of invertebrates (Lines and Plantz, 1981; USGS, 1980, 1981, 1982 and 1983; Waddell and others, 1982; and Price and Plantz, 1987) provide standards against which actual conditions in Grassy Trail Creek and several nearby creeks can be evaluated if desired.

Utah water quality standards exist for numerous parameters other than those mentioned above, but at this time there is no evidence to indicate, nor reason to believe that those parameters are of concern in the Book Cliffs III CIA. However, additional parameters recommended for routine monitoring in UDOGM directive Tech-004 are included in the water-monitoring plan of the West Ridge Mine operations.

MATERIAL DAMAGE

Material damage to the hydrologic balance would possibly manifest itself as an economic loss to the current and potential water users, would result in quantifiable reduction of the capability of an area to support fish and wildlife communities, or would cause other quantifiable adverse change to the hydrologic balance outside the permit area. The basis for determining material damage may be found to differ from site-to-site within the CIA according to specific site conditions. Surface-water and groundwater concerns have been identified for CHIA evaluation.

Parameters for surface-water quantity and quality

The potential material-damage concerns this CHIA focuses on are changes of surface flow rates and chemical composition that would physically affect the off-permit stream channel systems as they presently function and affect aquatic and wildlife communities and agricultural and livestock production. Therefore, criteria are intended to identify changes in the present discharge regime that might be indicators of economic loss to existing agricultural and livestock enterprises; of significant alteration to the channel size or gradient; or of a loss of capacity to support existing fish and wildlife communities. In order to assess the potential for material-damage to these elements of the hydrologic system, the following indicator parameters were selected for evaluation at each evaluation site: low-flow discharge rate, TDS, and sediment load.

The surface-water concerns will be evaluated at ST-3, ST-8, ST-9, and ST-10 in the Grassy Trail Creek drainage, ST-15 in the Spring Canyon drainage, S-80 in Hanging Rock Canyon, ST-11, ST12, and ST-13 in the Bear Canyon drainage, ST-5 in B-Canyon drainage, and ST-5, ST-6, and ST-6A in C-Canyon drainage. Surface water monitoring locations for the West Ridge Mine are identified on Plate 4.

Low-Flow Discharge Rate

Measurements provided by mine operators are generally of instantaneous flow and provide some indication of long-term trends, but are probably no more accurate either individually or as a whole than the USGS measurements. In the Wasatch Plateau, Waddell and others (1981) found that correlating three years of low-flow records (September) at stream sites against corresponding records from long-term monitoring sites would allow the development of a relationship that could be used to estimate future low-flow volumes at the stream sites within a standard deviation of approximately 20 %. Ten years of measurements reduced the standard deviation to 16 - 17 % and 15 years of data reduced it to about 15 %. This relationship has not been demonstrated for streams in the Book Cliffs; however, it indicates that a change in low-flow rates of less than 15 to 20 % probably would not be detectable. A 20 % decrease in the low-flow rate will provide a threshold indicator that decreased flows are persisting and that an evaluation for material damage is needed.

Monitoring of mine-discharge rates during low-flow periods will also provide a means to evaluate effects of the mine discharge on the receiving streams. The potential for material damage by mine discharge water is tied to the effect of that discharge on the flow in the receiving streams, and that effect will be most pronounced during low-flow. Water from the West Ridge Mine disturbed area will be monitored at the UPDES discharge point at the sediment pond. Direct discharge from the mine will be monitored at the UPDES point located near the mine portals, a culvert riser that leads directly into the main bypass culvert.

Total Dissolved Solids (TDS)

The concentration of dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. Wildlife and livestock use is the designated postmining land use, so established dissolved solids tolerance levels for wildlife and livestock have been adopted as the thresholds beyond which material damage may occur. The state standard for TDS for irrigation of crops and stockwatering (Class 4) is 1,200 mg/L. If TDS concentrations persistently exceed 1,200 mg/L it will be an indication that evaluation for material damage might be needed. On Soldier Creek there have been single samples from both UPDES and stream monitoring in which TDS has exceeded this 1,200 mg/L threshold.

Monitoring of Grassy Trail Creek by Sunnyside Mines (Figure 2) showed that from 1989 through 1992, when sampling ceased, TDS consistently exceeded 1,200 mg/L at GT-4, located between the Sunnyside Mine and the town of Sunnyside. During this same period TDS concentrations also increased at GT-2 and GT-3, monitoring sites upstream of the main mine area. Monitoring of ST-10 began in 2002 and will monitor undisturbed flow up-gradient of the permit area.

Sediment Load

Sediment is a common constituent of ephemeral stream flow in the western United States. The quantity of sediment in the flows affects stream-channel stability and most uses of the water. Excessive sediment deposition is detrimental to existing aquatic and wildlife communities. Large concentrations of sediment in streamflow may preclude use of the water for irrigating crops because fine sediment tends to reduce infiltration rates in the irrigated fields, and the sediment reduces capacities of storage facilities and damages pumping equipment. Sediment load measurement error is, at a minimum, the same as the flow measurement error because sediment load is directly dependent on flow and in practice cannot be measured more accurately than the flow.

TSS is the indicator parameter initially chosen for evaluating the sediment hazard to stream-channel stability and irrigation. Threshold values have initially been set as the greater of 1 standard error above the baseline mean TSS value or 120 % of the baseline mean TSS value (by analogy with the low-flow discharge rate measurement accuracy and assuming that the error in TSS will contribute equally to the error in flow when determining mean sediment load). If TSS concentrations persistently exceed these threshold values it will be an indication that evaluation for material damage from sediment load in the streams might be needed.

Parameters for groundwater quantity and quality

The potential material-damage concerns this of CHIA are intended to limit changes in the quantity and chemical composition of water from groundwater sources to magnitudes that: will not cause economic loss to existing or potential agricultural and livestock enterprises; will not degrade domestic supplies, would not cause structural damage to the aquifers; and will maintain adequate capacity for existing fish and wildlife communities.

To assess the potential for material damage to these elements of the groundwater hydrologic system, the following indicator parameters were selected for evaluation: seasonal flow from springs and TDS concentration in spring and mine-discharge water.

Groundwater concerns will be monitored at six springs in Whitmore Canyon drainage (SP-12, SP-13, SP-15, SP-16, WR-1, and WR-2), two springs in Spring Canyon drainage (SP-101 and SP-102), one spring in Hanging Rock Canyon (S-80), and one in C Canyon (SP-8). Drill hole DH-86-2 will also monitor groundwater in C Canyon, within the West Ridge Mine permit area. Groundwater monitoring locations for the West Ridge Mine are identified on Plate 4.

Seasonal flow from springs

Maintain potentiometric heads that sustain average spring discharge rates, on a seasonal basis, equal or greater than 80 % of the mean seasonal baseline discharge, or in other words baseline minus 20 % probable measurement error. The 20 % measurement error is based on analogy with the accuracy of measuring low-flow surface discharge rates. A 20 % decrease in flows, determined on a seasonal basis, will indicate that decreased flows are probably persisting and that an evaluation for material damage is needed.

TDS concentration

The concentration of total dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. The quality of water from underground sources reflects the chemical composition of the rocks it passes through. Groundwater quality may be degraded by intrusion of poorer quality water from wells or mines, by leakage from adjoining formations, or by recharge through disturbed materials. Groundwater discharging from seeps and springs is used by wildlife and livestock, and those are the designated postmining land uses. There is no water quality standard for TDS for aquatic wildlife. The state standard for TDS for irrigation of crops and stockwatering (Class 4) is 1,200 mg/L. If TDS concentrations persistently exceed 1,200 mg/L it will be an indication that evaluation for material damage might be needed.

Water samples collected from several locations inside the Sunnyside Mine, in particular sumps, consistently had TDS levels in excess of 1,200 mg/L; many of the samples from areas other than sumps had better quality water with TDS levels between 400 to 800 mg/L, which is probably more representative of the groundwater that was flowing into the mines. TDS levels in drill hole DH-86-1 were also in the 400 to 800 mg/L range, but 15 of 17 samples from DH-86-1 had TDS above 1,200 mg/L. Waters from springs SP-6, SP-8, and PC-1 also are high in TDS.

VI. ESTIMATE PROBABLE FUTURE IMPACTS OF MINING ACTIVITY

GROUNDWATER

Dewatering and subsidence related to mining have the greatest potential for impacting groundwater resources in the CIA.

Dewatering

Underground mining removes the support to overlying rock causing caving and fracturing of the overburden. In most mining areas it is unlikely that fractures will reach shallower perched aquifers because of the thickness of the overburden, but in areas where fracturing is extensive, subsidence induced caving and fracturing can create conduits that allow groundwater to flow into the mine. Dewatering caused by fracturing may decrease aquifer storage and groundwater flow to streams and springs (Figure 5). Water quality downstream from the mines could improve because water being discharged from coal mines in the Book Cliffs and Wasatch Plateau is often of better quality than natural spring flow or base flow.

Total groundwater storage above the Gilson seam at the Soldier Canyon Mine has been estimated to be 490,000 ac-ft, assuming an average saturated thickness of 1,000 feet, an area of 4,900 acres, and a storage coefficient of 0.10 (Soldier Canyon Mine MRP p. 7-28). At the West Ridge Mine, the maximum cover exceeds 2,500 feet and the average overburden is approximately 1,500 feet, so 1,000 feet may be a reasonably conservative estimate of saturated thickness for West Ridge. The total size of the West Ridge permit area is 6,114.89 acres (9.6 mile^2). Therefore, an estimate of maximum total groundwater storage above possible West Ridge mine workings is 611,489 ac-ft.

Annual average groundwater recharge for the 10.4 mile^2 of the Soldier Canyon Mine permit area has been estimated to be 740 ac-ft using 9 % as the average infiltration factor. Groundwater recharge is expected to be similar for the 9.6 mile^2 West Ridge Mine (approximately 680 ac-ft). Recharge and discharge relations for the Dugout Canyon area are discussed on pages 7-30 and 7-31 of the Dugout Canyon Mine MRP, but no estimate of recharge volume is made. Because of hydrologic isolation between the Blackhawk Formation and the surface, West Ridge Resources, Inc. does not foresee an increase in recharge rates or a decrease in discharge rates at the surface because of dewatering of deeper strata. Another reason that a notable or measurable increase in recharge is also unlikely is because recharge is generally available only for a few months during spring snowmelt and for very brief periods during summer thundershowers. During these seasonal, relatively short events the soils reach saturation quickly and reject most available water.

The Blackhawk Formation is probably saturated in most areas (Waddell and others, 1986, p. 41) and the West Ridge Mine might be expected to produce water at rates similar to those observed in the Soldier Canyon Mine. Most water entering the Soldier Canyon Mine comes through leaks in the mine roof, and Mayo and Associates (Soldier Canyon Mine MRP, Appendix 7-3, p. 17) calculated that the average annual flow into the mine between 1988 and 1994 was approximately 680 ac-ft/yr. The average annual flow into the Soldier Canyon Mine between 1985 and 1991 increased from about 160 to approximately 1,000 ac-ft/yr, and the estimate of average groundwater interception due to continued mining activities at the Soldier Canyon Mine is 460 ac-ft/yr (Soldier Canyon Mine MRP, p. 7-28).

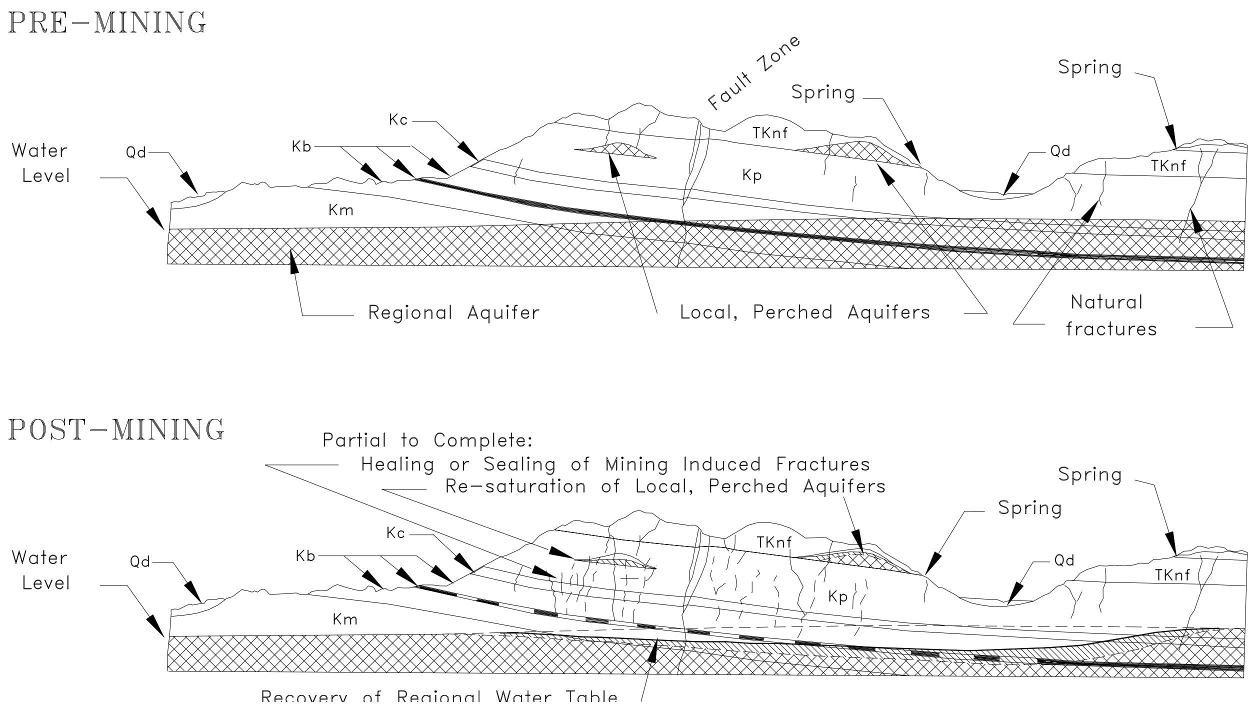

FIGURE 5

Subsidence

Subsidence impacts are largely related to extension and expansion of existing fracture systems and upward propagation of new fractures (Figure 5). Inasmuch as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjustment or realignment in the conduit system will inevitably produce changes in the configuration of groundwater flow. Potential changes include decreased flow through existing fractures that close, increased flow rates along existing fractures that open further, and the diverting of groundwater flow along new fractures or within newly accessible permeable lithologies. Subsurface flow diversion may cause the depletion of water in local aquifers and loss of flow to springs that are undermined. Increased flow rates along fractures could potentially improve water quality by reducing groundwater residence time.

Annual reports for 1988, 1989, 1992, 1993, 1994, 1995, and 1996 for the Soldier Canyon Mine indicate no subsidence over the current permit area (indicated elevation changes are within the limit of accuracy of the survey method). Mining has occurred beneath 500 to 2,000 feet of overburden and mining is projected to be done beneath up to 2,250 feet of cover. The Castlegate Sandstone and thick overburden are responsible for reduced surface subsidence at Soldier Canyon.

Mining at West Ridge is currently planned for the Lower Sunnyside seam only. Overburden thickness is projected to range from 325 feet to 2,800 feet, with an average thickness of approximately 1,500 feet. The Castlegate Sandstone is present at West Ridge and will help limit effects of subsidence at the surface. The potential for subsidence related surface impacts (e.g., ponding) to the subsurface and surface hydrologic regimes is not considered significant by West Ridge Resources, Inc.

SURFACE WATER

Changes in flow volume and in water quality have the greatest potential for impacting surface-water resources in the CIA. Sites that have been or are being used to monitor surface water are shown on Plate 4.

Water Quality

The quality of the local surface waters can be affected by two basic processes. First, the runoff from the operator's disturbed lands and waste piles could increase sediment concentrations and alter the distribution and concentration of dissolved solids in the receiving streams. This potential for inducing water quality changes in Grassy Trail and other streams has been fully recognized, and the runoff control plan established for the West Ridge Mine is adequate in anticipating, mitigating and monitoring the potential impacts.

The second potential cause of surface water quality changes is related to the location and chemistry of groundwater discharges, both from the mines and from springs and baseflow. The Flagstaff Limestone reservoir has high hydraulic diffusivity. Perennial flow of Soldier Creek is sustained by spring and seep discharge and baseflow from the Flagstaff Limestone during spring and early summer snowmelt; however, discharge the during the fall and winter is greatly reduced and discharge from underlying formations, mainly the Blackhawk, sustains the stream flow (Waddell and others, 1986, p. 28). In Whitmore Canyon and the West Ridge area the Flagstaff Limestone is thin and poorly exposed, so it does not contribute significantly to sustaining stream flow at any time of year.

TDS concentration in groundwater from the Flagstaff Limestone is generally lower than that in groundwater from underlying formations. In upper Pine Creek TDS was 200 to 300 mg/L in water-years 1979 and 1980, with magnesium, calcium and bicarbonate ions dominant; however, in lower Soldier Canyon where baseflow is from the North Horn and Blackhawk Formations, TDS ranged from about 300 to 700 mg/L. At low flow the dominant ions were sodium, magnesium, sulfate, and carbonate, but at high flow calcium and bicarbonate dominated

(Waddell and others, 1982; 1986), because groundwater from the Blackhawk was contributing a smaller portion of total flow and therefore had a smaller effect on the quality of the stream water. Based on data from water-year 1979 at station 09314340 on Grassy Trail Creek the dominant ions at low flow were calcium and sulfate and at high flow were magnesium and bicarbonate (Figure 17 in Lines and Plantz, 1981).

Discharge water from the Sunnyside Mines, located southeast of West Ridge, had TDS concentrations of about 1,600 mg/l, with the dominant ions being sodium, sulfate, and bicarbonate (Sunnyside Coal Company, 1993). The chemical composition was similar to that of water in contact with the Mancos Shale. The TDS concentration of discharge water from the West Ridge Mine will likely be similar to discharge from the Sunnyside Mines.

TDS in Grassy Trail Creek at USGS station 0931430, at the mouth of Whitmore Canyon and near the upper contact with the Mancos Shale, averaged 988 mg/L between 1979 and 1984, with the dominant ions being sodium, sulfate, and bicarbonate (Waddell, 1981).

Grassy Trail Creek is monitored at four locations: ST-3 is located below the confluence with Hanging Rock Canyon, and ST-8 is located just above the confluence with Water Canyon and downstream of the West Ridge Mine permit area and Grassy Trail Reservoir, ST-9 is located at the inlet of Grassy Trail Reservoir, and ST-10 is located at the uppermost permit boundary. Spring Creek will be monitored for baseline parameters beginning in the fall of 2005 for the addition of State Lease ML 47711: ST-15 is located in Spring Creek just before the confluence with Grassy Trail Creek.

On the west side of West Ridge, five stations will monitor ephemeral drainages contributing to lower Grassy Trail Creek: ST-5 below the confluence of B and C Canyons; ST-6A and ST-6, respectively above and below the mine site in C Canyon; and ST-7 in lower A Canyon. ST-5 is equipped with a crest gauge and an ISCO automatic sampler while ST-6A, ST-6 and ST-7 will each have a crest gauge and bottle samplers. ST-4 in lower Bear Canyon was eliminated from the monitoring plan in July 2005 and replaced with additional monitoring sites ST-11, ST-12, and ST-13 to more closely monitor the subsidence effects to the intermittent Right Fork of Bear Canyon drainage.

Surface water at ST-2 on upper Bear Creek is a magnesium-, bicarbonate-, and sulfate-type water with 1,100 mg/L TDS. Only one surface water sample was collected at M-2 on lower Bear Creek, and that sample had TDS of 1,820 mg/l. The quality of water in Bear Canyon appears to degrade rapidly as it flows between ST-2 and M-2, from the canyon into Clark Valley.

Both the B and C Canyon drainages respond as ephemeral drainages, but baseline observations at ST-5 indicate that all of the flow comes from the B Canyon drainage, primarily the lower drainages and adjacent Mancos slopes. ST-6 and ST-6A are located, respectively, below and above the proposed mine site in C Canyon. The crest gauges did not record any flow in the channel during baseline monitoring in 1997 or 1998 even though the rain gauge in C Canyon recorded precipitation events of up to two inches during that period. Based on monthly monitoring of ST-4 during 1997 and 1998, West Ridge Resources determined that intermittent flow does not occur in the lower section of Bear Creek and that the channel responds only as an ephemeral drainage following substantial rainfall events. However, following field reconnaissance in June 2005 prior to the addition of State Leases ML 47711 and ML 49287, it was determined that the Bear Canyon is an intermittent drainage. This was based on the flow observations at the time of the visit (30 gpm not in response to a substantial rainfall event), riparian vegetation supported along the stream channel, in addition to the fact that the watershed is greater than one-square mile, which would qualify it as an intermittent stream as defined in R645-100-200, Definitions, "Intermittent Streams".

The West Ridge mine water is discharged into the C Canyon drainage. In addition to being monitored at ST-5 and ST-6, discharged water is subject to monthly monitoring stipulated by a UPDES permit (Permit No. UTG040023, outflow #2). Because the monitoring required under the UPDES permit is more stringent and more frequent than that proposed in this permit application, discharge samples are collected from the UPDES discharge monitoring point rather than at the drainage monitoring stations.

The West Ridge Mine UPDES permit contains limitations on TDS (one-ton/day), total suspended solids (30-day average, 25 mg/L; 7-day average, 35 mg/L; daily maximum, 70 mg/L), total settleable solids (0.5 ml/L for storm-water discharges), total iron (1.0 mg/L), oil and grease (10 mg/L), and pH (between 6.5 and 9.0). There is no limit on flow, but it is to be measured monthly, and the duration of intermittent discharge is to be reported along with flow. Additionally, there can be no more than a trace amount of visible sheen, floating solids, or foam and no discharge of sanitary waste or coal process water. Monitoring is to be by monthly grab samples.

The West Ridge Mine discharge at UPDES outflow #2 has exceeded the permitted TDS limit of 2000 lbs/day for seven months between March 2004 and March 2005. The increased daily maximum load is due to a combination of increased discharge and slightly higher TDS concentrations. The mine has been cooperating with the DWQ to amend their UPDES permit to become compliant. As of August 2005, the West Ridge Mine is applying for an individual UPDES Permit that includes provisions to implement a salinity-offset project.

West Ridge Mine Sediment Control

The West Ridge sedimentation pond is designed to control sediment flow from the mine yard disturbed area to C Canyon. The sediment pond is designed for the complete retention of the 10 year, 24 hour storm event. The expected sediment from the mine yard disturbed area is 0.3090 ac-ft/yr, and the sediment pond has been designed to handle the sediment yield from the disturbed area and retain it in the pond. This effectively reduces the sediment yield from the disturbed area to an insignificant amount during the operational phase of the mine. There has been no reported discharge from the sedimentation pond since construction through March 2005. Drainage from undisturbed areas will, for the most part, be carried under the mine site through a bypass culvert.

The principal spillway is a 24-inch cmp culvert in cell C, fitted with an oil skimmer. This spillway carries the peak flow from the 25 year, 6 hour event at a depth of 1.05 feet over the pipe. The emergency spillway, located on cell B and constructed of concrete or grouted riprap, conveys any flow in excess of the 25 year, 6 hour precipitation event out of the pond. Both spillways flow directly into the bypass culvert.

When the site has been regraded for reclamation, silt fences will be installed adjacent to the reclaimed channel, approximately along contour and with overlapping ends, to collect and contain sediment from the site. The surface of the regraded area will be gouged with a backhoe bucket to create large depressions that o act as sediment traps. The sediment yield from the reclaimed area is anticipated to be similar to adjacent undisturbed areas.

Alternate sediment control areas (ASCA) are used in areas where the surface disturbance is minor and sediment control is expected to be restored fairly rapidly with revegetation. At the topsoil stockpiles, ditches divert undisturbed area runoff away from the stockpiles, silt fencing is placed around the stockpiles to minimize siltation from the stockpile, the surface of the stockpiles are pocked and roughened to retain moisture and minimize runoff, and the surface of the piles have been revegetated to minimize surface erosion. The office and parking lot area below the mine yard facility area are sloped to one end, where silt fencing is used for sediment control, and the slopes and embankment of the office pad have been revegetated to control sedimentation and erosion.

Water Quantity

Grassy Trail Creek and possibly Spring Creek (once baseline flow is established) are the only perennial streams in the permit and adjacent areas. Grassy Trail Creek is monitored at four locations, at ST-3 located below the confluence with Hanging Rock Canyon and upstream of Grassy Trail Reservoir, at ST-8 located just above the confluence with Water Canyon and downstream of Grassy Trail Reservoir, at ST-9 as Grassy Trail Creek enters the reservoir, and ST-10 at the northernmost boundary where undisturbed Grassy Trail Creek enters the permit area. Spring Creek will be monitored for baseline parameters beginning in the fall of 2005 for the addition of State Lease ML 47711: ST-15 is located in Spring Creek just before the confluence with Grassy Trail Creek.

On the west side of West Ridge, four stations monitor ephemeral drainages contributing to lower Grassy Trail Creek: ST-5 below the confluence of B and C Canyons; ST-6A and ST-6, respectively above and below the mine site in C Canyon; and ST-7 in lower A Canyon. ST-5 is equipped with a crest gauge and an ISCO automatic sampler while ST-6A, ST-6 and ST-7 each have a crest gauge and bottle samplers. ST-4 in lower Bear Canyon was eliminated from the monitoring plan in July 2005 and replaced with additional monitoring sites ST-11, ST-12, and ST-13 to more closely monitor the subsidence effects to the intermittent Right Fork of Bear Canyon drainage.

Both the B and C Canyon drainages respond as ephemeral drainages, but baseline observations at ST-5 indicate that all of the flow comes from the B Canyon drainage, primarily the lower drainages and adjacent Mancos slopes. ST-6 and ST-6A are located, respectively, below and above the proposed West Ridge Mine in C Canyon. The crest gauges did not record any flow in the channel during baseline monitoring in 1997 or 1998 even though the rain gauge in C Canyon recorded precipitation events of up to two inches during that period. Based on monthly monitoring of ST-4 during 1997 and 1998, West Ridge Resources determined that intermittent flow does not occur in the lower section of Bear Creek and that the channel responds only as an ephemeral drainage following substantial rainfall events. However, following field reconnaissance in June 2005 prior to the addition of State Leases ML 47711 and ML 49287, it was determined that the Bear Canyon is an intermittent drainage. This was based on the flow observations at the time of the visit (30 gpm not in response to a substantial rainfall event), riparian vegetation supported along the stream channel, in addition to the fact that the watershed is greater than one-square mile, which would qualify it as an intermittent stream as defined in R645-100-200, Definitions, "Intermittent Streams".

The West Ridge mine water is discharged into the C Canyon drainage. In addition to being monitored at ST-5 and ST-6, discharged water is subject to monthly monitoring stipulated by a UPDES permit (Permit No. UTG040023, outflow #2). As shown in Figure 1, the mine operator reported the daily average discharges for each month ranging from 1 to 194 gpm from February 2003 through December 2004 (DWQ DMRs and UDOGM electronic database). Based on these daily average discharge rates, the total yearly discharge is calculated to be approximately 200 and 210 acre-feet for 2003 and 2004, respectively. Daily average discharge has increased to between 240 and 350 gpm in the first quarter 2005.

Upon termination of mining operations, discharge of groundwater from the West Ridge Mine to C Canyon will be discontinued and the mine will begin to flood. It is anticipated that there will be an initial reduction in surface flow because of the loss of the mine discharge. However, surface flow may recover to pre-mining conditions if base flow to the stream is reestablished as the mine floods. The time required for mine flooding will depend not only on the rate of water inflow but also on the amount of caving and the void space remaining after caving. Complete flooding of the mine may never occur because flow out of the mine through the roof, floor, and ribs and into the surrounding rock will increase as flooding increases the hydraulic head within the abandoned workings.

ALLUVIAL VALLEY FLOORS

The West Ridge mine site will be the only surface disturbance within the CIA during the life of the mine. Factors are present within the permit area that will preclude the mine site, as well as the permit and adjacent areas, including the substitute topsoil borrow area, from classification as an alluvial valley floors (AVF). There is not the combination of groundwater features, soil matrix and farmland to classify any area within or immediately adjacent to the mine permit area as an AVF.

VII. ASSESS PROBABLE MATERIAL DAMAGE.

WEST RIDGE MINE

Planned operational monitoring will document any measurable changes in the surface- and groundwater systems. At the time of this writing, the West Ridge Mine has a relatively low inflow of water into the Mine based on the 200 and 210 acre-feet estimated annual discharge for 2003 and 2004, respectively. The total annual discharge including evaporation and extraction is estimated at 365.8 and 342.4 acre-feet for 2003 and 2004, respectively. This rate of dewatering is much lower than the estimated annual recharge rate of 611,489 acre-feet. Throughout most of the permit area, overburden thickness will be sufficient (500 to 2,800 feet) to restrict surface manifestations of subsidence. Subsurface propagation of fractures may produce changes in surface- and groundwater flow that could affect local aquifers, springs, and streams. Future monitoring will provide data applicable to documenting changes in the surface- and groundwater systems. If it is subsequently demonstrated that the mining has caused or will cause a diminution, contamination, or interruption of an appropriated water right or a material impact to the hydrologic balance either within or outside of the permit area, the Permittee will be required by UDOGM to address means of minimizing the impact and replacing any appropriated water rights.

Surface disturbance and UPDES permitted discharges are not expected to degrade groundwater quality or surface-water quality in Grassy Trail Creek or other drainages. Sediment control measures should continue to effectively prevent diminution of water quality in the receiving drainages.

No AVF will be impacted during the first five year permit term by additional flow from increased mine water discharge.

State Leases ML 47711 and ML 49287

Mining in the State Lease areas is projected to begin in September 2005. There will be no new surface disturbance for mining in this tract. Water inflow is expected to be similar to that in previous mining and any mine water discharge will be UPDES permitted. The intermittent creek to be undermined in the Right Fork of Bear Canyon has an overburden as little as 325 feet and is subject to additional monitoring for potential effects of subsidence on the stream channel and associated ecosystem. The Permittee has committed to mitigation if it is determined that damage has occurred. Spring Creek and springs in Spring Canyon and Little Spring Canyon will be monitored for baseline parameters and the PHC will be updated prior to mining in that area.

FUTURE MINING

Underground mining may result in some diversions of intercepted groundwater into drainages that are not topographically within (above) the area where the water was encountered.

If it is demonstrated that mining has caused or will cause a diminution, contamination, or interruption of an appropriated water right or a material impact either within or outside of the permit area, the permittee will be required by the Division to address means of minimizing the impact and replacing any appropriated water rights. Evaluations of PHCs and the preparation of this CHIA do not indicate that there is any evidence that such impacts will result from the proposed mining in the Book Cliffs III CIA, and as a consequence, there is no reason to require operators to propose alternatives for disposing of the displaced water or other possible actions as part of the PAP.

Increased rates of dewatering may in the future result in depletion of groundwater storage. Depletion of storage may terminate certain spring flows and base flow recharge to streams, in particular in Whitmore Canyon. Upon cessation of mining, mine water discharge will be discontinued. Mine flooding will probably result in reestablishment of the preexisting groundwater systems that, most likely, provided base flow to the streams.

Drainage from future surface disturbance will be managed through appropriate sediment controls. Future West Ridge Mine discharges will be directed through sediment ponds.

At the termination of mining, downstream potential AVF's will experience decreased flow as mine discharge stops. The duration and extent of this impact cannot be accurately assessed at this time. However, flow rates may be partially to fully restored when the groundwater system is reestablished by flooding of the abandoned mines.

The operational designs for the West Ridge Mine are determined, based on the information submitted in the mine plans and referenced literature, to be consistent with preventing damage to the hydrologic balance outside the mine plan areas.

VIII. STATEMENT OF FINDINGS.

Based on the information presented in this CHIA, the Utah Division of Oil, Gas and Mining finds that the proposed coal mining and reclamation operations of the West Ridge Mine have been designed to prevent material damage to the hydrologic balance outside the permit area. No evidence of material damage from actual mining operations in the CIA has been found. No probability of material damage from existing and anticipated mining operations in the CIA has been found.

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X. ABREVIATIONS

AVF	Alluvial Valley Floor
BLM	Bureau of Land Management
CIA	Cumulative Impact Area
CHIA	Cumulative Hydrologic Impact Area
DWR	Utah Division of Wildlife Resources
EA	Environmental Assessment
MRP	Mining and Reclamation Plan
MSHA	Mine Safety and Health Administration
PAP	Permit Application Package
PHC	Probable Hydrologic Consequences
PHDI	Palmer Hydrologic Drought Index
SMCRA	Surface Mining Control and Reclamation Act of 1977
UDOGM	Utah Division of Oil, Gas and Mining
UDWR	Utah Division of Water Resources
UDWQ	Utah Division of Water Quality
UPDES	Utah Pollution Discharge Elimination System
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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Plate 1 Location Map

Plate 2   Cumulative Impact Area Map

Plate 3 Geology

Plate 4 Hydrology